

VEHICLE CONTROL METHOD, VEHICLE CONTROL APPARATUS, VEHICLE CONTROL DEVICE, AND READABLE STORAGE MEDIUM

CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority to Chinese patent application No. 202111397825.8, filed on November 23, 2021, which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present application relates to a technical field of vehicle control, and in particular to a vehicle control method, a vehicle control apparatus, a vehicle control device, and a readable storage medium.

BACKGROUND

[0003] With rapid development of rail transit, the rail transit has brought a lot of convenience to people and users. However, energy consumption of the rail transit is very huge. For example, in the case of vehicle braking, some electrical energy can be generated and fed back to the power grid, but most of the energy generated by braking is wasted in the form of heat through the rheostat. Therefore, people are paying more and more attention to how to effectively conduct energy recovery and reuse.

[0004] At present, for example, by adjusting the parking time of the vehicle at the station, the cooperative control of multiple vehicles can be achieved, so that the braking energy is most effectively used. However, in the process of the cooperative control of multiple vehicles, the voltage is easy to rise, which affects the service life of the power grid, and is not conducive to the sustainable development of the rail transit.

[0005] Therefore, a reliable rail transit planning and control scheme is urgently needed to achieve the effective use of the braking energy.

SUMMARY

[0006] The embodiments of the present application provide a vehicle control method, a vehicle

control apparatus, a vehicle control device, and a readable storage medium, which can realize real-time planning of vehicle operation scheme, so as to control vehicle operation and realize effective recovery and utilization of braking energy generated by the vehicle.

[0007] In a first aspect, the embodiments of the present application provide a vehicle control method, comprising:

[0008] determining at least one first vehicle included in a first network and satisfying a braking condition;

[0009] determining at least one second vehicle matching the at least one first vehicle in the first network, wherein the first network is a power network of a region where the first vehicle is located, and the second vehicle is a vehicle satisfying a starting condition within the first network;

[0010] determining, according to a coasting time range and a parking braking rate range of each first vehicle as well as a starting time range of each second vehicle, a target vehicle control strategy corresponding to and satisfying a target braking energy absorbing power;

[0011] controlling operation of the first vehicle and the second vehicle respectively according to the target vehicle control strategy.

[0012] In some implementations of the first aspect, determining the at least one first vehicle included in the first network and satisfying the braking condition comprises:

[0013] acquiring in real time operation information of the first vehicle in the first network, wherein the operation information includes a preset parking braking rate of the first vehicle, a distance between the first vehicle and a preset parking point, and a first speed of the first vehicle;

[0014] determining, according to the preset parking braking rate of the first vehicle and the distance between the first vehicle and the preset parking point, a second speed of the first vehicle that enables the first vehicle to arrive at the preset parking point;

[0015] determining, under a condition that a difference between the first speed and the second speed is less than a preset speed threshold, that the first vehicle satisfies the braking condition.

[0016] In some implementations of the first aspect, determining the at least one second vehicle matching the at least one first vehicle in the first network comprises:

[0017] determining at least one third vehicle parked at a platform in the first network and acquiring in real time platform parking information of each third vehicle, wherein the platform

parking information includes a parking duration of the third vehicle and a preset parking duration of the third vehicle;

[0018] determining, under a condition that a difference between the parking duration of the third vehicle and the preset parking duration of the third vehicle is less than or equal to a preset time threshold, the third vehicle as the second vehicle.

[0019] In some implementations of the first aspect, determining, according to the coasting time range and the parking braking rate range of each first vehicle as well as the starting time range of each second vehicle, the target vehicle control strategy corresponding to and satisfying the target braking energy absorbing power comprises:

[0020] inputting the coasting time range and the parking braking rate range of each first vehicle as well as a target starting time range of each second vehicle matching the first vehicle into a preset optimization model, and obtaining the target vehicle control strategy corresponding to and satisfying the target braking energy absorbing power;

[0021] wherein the preset optimization model includes a target optimization function, and the target optimization function is:

$$E(x) = \sum_{i=1}^N \alpha \int_{T_s}^{T_e} P_i(t) dt$$

[0022] wherein N is a number of the at least one second vehicle, α is a braking energy consumption conversion rate, T_s is a braking start time, T_e is a braking end time, and $P_i(t)$ is an absorbing braking energy power function of an i^{th} second vehicle of the at least one second vehicle.

[0023] In some implementations of the first aspect, within a first preset time period, under a condition that the at least one first vehicle includes a plurality of first vehicles, determining, according to the coasting time range and the parking braking rate range of each first vehicle as well as the starting time range of each second vehicle, the target vehicle control strategy corresponding to and satisfying the target braking energy absorbing power comprises:

[0024] determining, according to a preset matching condition, M matching schemes for the first vehicle and the second vehicle, wherein M is an integer greater than 1;

[0025] for each matching scheme, determining, according to the coasting time range and the parking braking rate range of each first vehicle as well as the target starting time range of each

second vehicle, a first control strategy of the matching scheme and a first braking energy absorbing power corresponding to the first control strategy;

[0026] determining a highest first braking energy absorbing power as the target braking energy absorbing power, and determining the first control strategy corresponding to the highest first braking energy absorbing power as the target vehicle control strategy.

[0027] In some implementations of the first aspect, the preset matching condition includes a first matching condition and a second matching condition;

[0028] the first matching condition is that in each matching scheme, a number of the first vehicles is less than or equal to a number of the second vehicles, and the number of the first vehicles is greater than or equal to half of the number of the second vehicles;

[0029] the second matching condition is that under a condition that the number of the first vehicles is greater than the number of the second vehicles, according to distances each between one of the first vehicles and one of the second vehicles, the number of the second vehicles in the matching scheme is determined from a smallest distance to a largest distance, so that the matching scheme satisfies the first matching condition.

[0030] In some implementations of the first aspect, the target vehicle control strategy comprises adjusting a target starting time of the second vehicle, and controlling the operation of the first vehicle and the second vehicle respectively according to the target vehicle control strategy comprises:

[0031] controlling, under a condition that a time difference between the target starting time of the second vehicle and a preset starting time of the second vehicle is less than a preset time threshold, the first vehicle to brake and the second vehicle to start according to the target vehicle control strategy; or

[0032] transmitting, under a condition that the time difference between the target starting time of the second vehicle and the preset starting time of the second vehicle is greater than or equal to the preset time threshold, the target vehicle control policy to a vehicle control management platform for the vehicle control management platform generating a target instruction;

[0033] controlling, under a condition that the target instruction is received, the operation of the first vehicle and the second vehicle respectively according to the target vehicle control strategy.

[0034] In a second aspect, the embodiments of the present application provide a vehicle control

apparatus, comprising:

[0035] a processing module configured for determining at least one first vehicle included in a first network and satisfying a braking condition;

[0036] a data acquisition module configured for determining at least one second vehicle matching the at least one first vehicle in the first network, wherein the first network is a power network of a region where the first vehicle is located, and the second vehicle is a vehicle satisfying a starting condition within the first network;

[0037] the processing module being further configured for determining, according to a coasting time range and a parking braking rate range of each first vehicle as well as a starting time range of each second vehicle, a target vehicle control strategy corresponding to and satisfying a target braking energy absorbing power;

[0038] a control module configured for controlling operation of the first vehicle and the second vehicle respectively according to the target vehicle control strategy.

[0039] In a third aspect, the embodiments of the present application provide a vehicle control device comprising a processor and a memory storing computer program instructions; wherein the processor, when executing the computer program instructions, implements the vehicle control method described in the first aspect or any of the implementations of the first aspect.

[0040] In a fourth aspect, the embodiments of the present application provide a readable storage medium having computer program instructions stored thereon, wherein the computer program instructions, when executed by a processor, implement the vehicle control method described in the first aspect or any of the implementations of the first aspect.

[0041] According to the vehicle control method, the vehicle control apparatus, the vehicle control device, and the readable storage medium provided by the embodiments of the present application, for a same power network region, the first vehicle satisfying the braking condition may be firstly determined, then, the first vehicle may be matched to the second vehicle satisfying the starting condition within the same power network region. Then, the target vehicle control strategy corresponding to and satisfying the target braking energy absorbing power may be determined according to the coasting time range and the parking braking rate range of each first vehicle as well as the starting time range of each second vehicle. Thus, the control strategy of the first vehicle and the second vehicle can be adjusted according to the real-time inbound status of

the vehicle. Finally, the braking of the first vehicle and the operation of the second vehicle can be respectively controlled according to the target vehicle control strategy, so as to ensure that the braking energy can be effectively absorbed and utilized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0042] In order to more clearly illustrate the technical solutions of the embodiments of the present application, the accompanying drawings to be used in the embodiments of the present application will be briefly introduced below. For those of ordinary skill in the art, other accompanying drawings can be obtained based on these accompanying drawings without inventive effort.

[0043] Fig. 1 is a schematic flowchart of a vehicle control method provided by an embodiment of the present application;

[0044] Fig. 2 is a schematic curve diagram of a braking energy absorbing power provided by an embodiment of the present application;

[0045] Fig. 3 is a schematic diagram of a vehicle operation condition provided by an embodiment of the present application;

[0046] Fig. 4 is a schematic structural diagram of a vehicle control apparatus provided by an embodiment of the present application;

[0047] Fig. 5 is a schematic structural diagram of a vehicle control device provided by an embodiment of the present application.

DETAILED DESCRIPTION

[0048] Features and exemplary embodiments of various aspects of the present application will be described in detail below, and in order to make the purpose, technical solutions, and advantages of the present application clearer, the present application is described in further detail below in conjunction with the accompanying drawings and specific embodiments. It should be understood that the specific embodiments described herein are intended only to explain the present application and not to limit the present application. For those skilled in the art, the present application can be implemented without some of these specific details. The following description of the embodiments is intended only to provide a better understanding of the present

application by illustrating examples of the present application.

[0049] It should be noted that, in the present application, the relational terms, such as first and second, are used merely to distinguish one entity or operation from another entity or operation, without necessarily requiring or implying any actual such relationships or orders for these entities or operations. Moreover, the terms “comprise”, “include”, or any other variants thereof, are intended to represent a non-exclusive inclusion, such that a process, method, article or device including a series of elements includes not only those elements, but also other elements that are not explicitly listed or elements inherent to such a process, method, article or device. Without further limitation, an element preceded by “including...” does not exclude presence of additional similar elements in a process, a method, an article or a device including the element.

[0050] With rapid development of rail transit, the rail transit has brought a lot of convenience to people and users. However, energy consumption of the rail transit is very huge. For example, in the case of vehicle braking, some electrical energy can be generated and fed back to the power grid, but most of the energy generated by braking is wasted in the form of heat through the rheostat. Therefore, people are paying more and more attention to how to effectively conduct energy recovery and reuse.

[0051] At present, for example, by adjusting the parking time of the vehicle at the station, the cooperative control of multiple vehicles can be achieved, so that the braking energy is most effectively used. However, in the process of the cooperative control of multiple vehicles, the voltage is easy to rise, which affects the service life of the power grid, and is not conducive to the sustainable development of the rail transit. For another example, by optimizing the train schedule to realize energy recovery and reuse, in the existing technical solutions, the energy saving effect in practical application is not ideal. Therefore, a reliable rail transit planning and control scheme is urgently needed to achieve the effective use of the braking energy.

[0052] With respect to the problem mentioned in the background, the embodiments of the present application provide a vehicle control method, a vehicle control apparatus, a vehicle control device, and a readable storage medium. Here, for a same power network region, the first vehicle satisfying the braking condition may be firstly determined, then, the first vehicle may be matched to the second vehicle satisfying the starting condition within the same power network region. Then, the target vehicle control strategy corresponding to and satisfying the target

braking energy absorbing power may be determined according to the coasting time range and the parking braking rate range of each first vehicle as well as the starting time range of each second vehicle. Thus, the control strategy of the first vehicle and the second vehicle can be adjusted according to the real-time inbound status of the vehicle. Finally, the braking of the first vehicle and the operation of the second vehicle can be respectively controlled according to the target vehicle control strategy, so as to ensure that the braking energy can be effectively absorbed and utilized.

[0053] The vehicle control method provided by the embodiments of the present application is firstly introduced below. Fig. 1 is a schematic flowchart of a vehicle control method provided by an embodiment of the present application. As shown in Fig. 1, the method may include step 110 to step 140.

[0054] Step 110, determining at least one first vehicle included in a first network and satisfying a braking condition.

[0055] Here, the first network is a power network of a region where the first vehicle is located.

[0056] In the embodiments of the present application, in order to know the operation of each vehicle in real time, the vehicles located in the power network of the same region can communicate with each other, and share the operation of the vehicle itself.

[0057] For example, the communication mode between the vehicles located in the power network of the same region may be a distributed management mode or a central management mode, which is not specifically limited here.

[0058] The communication mode of the distributed management mode may maintain for each vehicle a group of communication lists between vehicles. By using the communication mode of the distributed management mode, the real-time communication between the vehicles can be improved.

[0059] The communication mode of the central management mode is that the vehicles in the power network of the same region are connected with a central processing device. A group of communication lists between the vehicles is stored in the central processing device, and each vehicle may communicate with the central processing device to know the operation of other vehicles in the power network of the same region. Here, the central processing device may be a preset vehicle in the power network of the same region, or a server configured on the ground,

which is not specifically limited here. By using the communication mode of the central management mode, the communication structure can be simplified and the implementation cost can be reduced.

[0060] In some embodiments, a vehicle in an inbound parking state (i.e., the vehicle has entered the braking state) may generate electricity through the braking system during the braking process of the vehicle. Under a condition that the vehicle in the inbound parking state and the vehicle in an outbound starting state are overlapped in time, the generated electricity may be transferred to the vehicle in the outbound starting state, which can realize the traction of the vehicle in the outbound starting state. That is, the outbound and started vehicle enters into a traction state, which can effectively utilize the energy generated from the braking of the vehicle.

[0061] For the vehicles in the power network of the same region, in order to effectively combine the operation states between different vehicles, to realize the real-time determination of the target vehicle control strategy, and to achieve the purpose of efficient energy recovery and energy reuse, the present application is provided. Therefore, in the embodiments of the present application, the at least one first vehicle included in the first network and satisfying the braking condition may be determined, then the first vehicle may be matched to the second vehicle, so that the energy generated by the braking of the first vehicle can be effectively transmitted to the second vehicle.

[0062] In some embodiments, the first network is the power network of the region where the first vehicle is located. In the power network of the region, there may be a plurality of platforms, and each platform may correspond to vehicles having different driving directions. Therefore, there may be a plurality of vehicles in the power network of the region. Accordingly, in the same network region, one first vehicle satisfying the braking condition can be included, or a plurality of first vehicles satisfying the braking condition can be included at the same time.

[0063] In order to timely identify whether the vehicle entering the platform is the first vehicle satisfying the braking condition, the first vehicle may be determined according to step 111 to step 113.

[0064] Step 111, acquiring in real time operation information of the first vehicle in the first network, wherein the operation information includes a preset parking braking rate of the first vehicle, a distance between the first vehicle and a preset parking point, and a first speed of the

first vehicle.

[0065] In the embodiments of the present application, the moving direction of the first vehicle is the direction of entering the platform, and the preset parking point may include the platform at which the first vehicle needs to park. For each platform at which the first vehicle needs to park, a parking braking rate can be set in advance according to the actual needs.

[0066] Specifically, the first speed of the first vehicle is the current speed of the first vehicle. During the operation of the first vehicle, the distance between the first vehicle and the preset parking point and the current speed of the first vehicle can be obtained in real time.

[0067] Next, step 112 is performed.

[0068] Step 112, determining, according to the preset parking braking rate of the first vehicle and the distance between the first vehicle and the preset parking point, a second speed of the first vehicle that enables the first vehicle to arrive at the preset parking point.

[0069] Specifically, the second speed is the desired speed that the first vehicle can arrive at the preset parking point. Specifically, based on the distance between the first vehicle and the preset parking point, and the preset parking braking rate of the first vehicle, the current desired speed (i.e., the second speed) can be calculated for the first vehicle parking at the preset parking point.

[0070] After the second speed is calculated, step 113 may be performed.

[0071] Step 113, determining, under a condition that a difference between the first speed and the second speed is less than a preset speed threshold, that the first vehicle satisfies the braking condition.

[0072] In step 113, whether the first vehicle satisfies the braking condition may be determined by comparing the relationship between the current speed of the first vehicle and the desired speed.

[0073] In the embodiments of the present application, under a condition that the first vehicle satisfies the braking condition, it may be considered that the first vehicle is already in an end stage of the interval cruise and in a stage before the braking of the vehicle. For convenience of description, in the embodiments of the present application, the operation stage of the first vehicle satisfying the braking condition is described as the braking preparation stage.

[0074] For example, the preset speed threshold can be set to 5 km/h, and under a condition that the difference between the current speed of the first vehicle and the desired speed is less than 5

km/h, it may be considered that the first vehicle is in the braking preparation stage.

[0075] As a specific example, whether the first vehicle satisfies the braking condition may be determined according to formula (1).

$$\sqrt{2as} - v_1 < v_p \quad (1)$$

[0076] Here, a is the preset parking braking rate of the first vehicle, s is the distance between the first vehicle and the preset parking point, v_1 is the first speed, and v_p is the preset speed threshold.

[0077] In the embodiments of the present application, since the operation state of the first vehicle satisfying the braking condition is in a stage before the braking of the first vehicle, a sufficient adjustment range can be reserved to adjust the braking time and braking rate of the first vehicle, so as to improve the recovery and utilization efficiency of braking energy.

[0078] In the embodiments of the present application, after it is determined that the first network includes the first vehicle satisfying the braking condition, step 120 may be performed.

[0079] Step 120, determining at least one second vehicle matching the at least one first vehicle in the first network, here, the second vehicle is a vehicle satisfying a starting condition within the first network.

[0080] In the embodiments of the present application, after it is determined that the first network includes the first vehicle satisfying the braking condition, the first vehicle may be matched to the second vehicle. That is, the second vehicle may be found from the first network for using braking energy generated by the first vehicle.

[0081] In some embodiments, the starting condition may include the parking duration of the vehicle on the platform and the operation state of the vehicle.

[0082] For example, after the first vehicle is determined, the vehicle in the starting state in the first network may be immediately determined as the second vehicle for using the braking energy generated by the first vehicle. In another example, it is also possible to determine whether the second vehicle is included in the first network according to the parking time of the vehicle.

[0083] In some embodiments, in order not to affect the user's ride experience, when matching the first vehicle to the second vehicle, the specific steps may be as follows: determining at least one third vehicle parked at a platform in the first network and acquiring in real time platform parking information of each third vehicle, wherein the platform parking information includes a

parking duration of the third vehicle and a preset parking duration of the third vehicle; and determining, under a condition that a difference between the parking duration of the third vehicle and the preset parking duration of the third vehicle is less than or equal to a preset time threshold, the third vehicle as the second vehicle.

[0084] In the embodiments of the present application, under a condition that the second vehicle satisfies the matching condition, the second vehicle is in a stage that has not yet been started, and for the convenience of description, the operation stage of the second vehicle satisfying the starting condition is described as the starting preparation stage.

[0085] In some embodiments, in the process of determining the second vehicle, there may be one or more third vehicles parked at the platform within the first network range. For each third vehicle parked at the platform, the parking duration of the third vehicle may be obtained, that is, the parking duration during which the third vehicle has parked at the platform may be obtained. Further, the preset parking duration of each third vehicle may be obtained.

[0086] For each third vehicle, whether the third vehicle can be regarded as the second vehicle satisfying the starting condition may be determined by comparing the relationship between the parking duration of the third vehicle and the preset parking duration.

[0087] For example, the preset time threshold can be, for example, 5 seconds. Whether the third vehicle satisfies the starting condition may be determined according to formula (2).

$$t_m - t_s \leq t_p \quad (2)$$

[0088] Where t_m is the preset parking duration, t_s is the parking duration of the third vehicle, and t_p is the preset time threshold.

[0089] According to the embodiments of the present application, since the second vehicle is in the starting preparation stage, there is a time interval to the real starting time of the second vehicle. Therefore, in order to enable the second vehicle to make full use of the braking energy generated by the first vehicle, the time interval between the starting preparation stage and the real starting time can be conveniently adjusted to realize the efficient use of braking energy.

[0090] In the embodiments of the present application, after the first vehicle is determined and the second vehicle matching the first vehicle is determined, step 130 may be performed to determine the target vehicle control strategy.

[0091] Step 130, determining, according to a coasting time range and a parking braking rate

range of each first vehicle as well as a target starting time range of each second vehicle, a target vehicle control strategy corresponding to and satisfying a target braking energy absorbing power.

[0092] Specifically, since the first vehicle is in the braking preparation stage and the second vehicle is in the starting preparation stage, the driving parameters of the first vehicle and the second vehicle are in the adjustable range.

[0093] In some embodiments, the target braking energy absorbing power may be set to determine the target vehicle control strategy that can satisfy the target braking energy absorbing power. For example, the target vehicle control strategy may include a target coasting time and a target parking braking rate of the first vehicle as well as the target starting time of the second vehicle.

[0094] In some embodiments, in order not to affect the normal operation of the vehicles, when determining the coasting time range and the parking braking rate range of the first vehicle, it can be set according to a preset train schedule. For example, the arrival time of the first vehicle is earlier than or equal to the time preset in the train schedule.

[0095] In order to improve the passenger's travel experience, the target starting time range of the second vehicle can be determined according to the minimum platform parking time and the maximum platform parking time. For example, the target starting time of the second vehicle in the target vehicle control strategy should make the platform parking time of the second vehicle within a range from the minimum platform parking time to the maximum platform parking time.

[0096] In the embodiments of the present application, the coasting time range and the parking braking rate range of each first vehicle as well as the target starting time range of each second vehicle can be reasonably set according to the specific actual operation of the vehicle and the travel safety and travel experience of the passengers, which is not specifically limited here.

[0097] Fig. 2 is a schematic curve diagram of a braking energy absorbing power provided by an embodiment of the present application. Here, the shadow part may represent the braking energy absorbing power. Further referring to Fig. 2, T1-T2 may be used to indicate that the first vehicle is in a coasting state, T2-T3 may be used to indicate that the first vehicle is in a braking state, and T4-T5 may be used to indicate that the second vehicle is in an accelerating state. During T1-T3, the first vehicle can generate braking energy, and after T4, the second vehicle can consume the braking energy.

[0098] In some embodiments, the optimization function can be set in advance according to the actual design requirements, and the target vehicle control strategy is calculated and obtained, so that the first vehicle and the second vehicle cooperate with each other to enable the braking energy absorbing power to reach the target braking energy absorbing power.

[0099] After the target vehicle control strategy is obtained, step 140 may be performed.

[00100] Step 140, controlling operation of the first vehicle and the second vehicle respectively according to the target vehicle control strategy.

[00101] Specifically, the target vehicle control strategy may include the target coasting time and the target parking braking rate of the first vehicle as well as the target starting time of the second vehicle. Therefore, the operation of the first vehicle and the second vehicle can be respectively controlled according to the target vehicle control strategy.

[00102] According to the embodiment of the present application, for the same power network region, the target vehicle control strategy corresponding to and satisfying the target braking energy absorbing power may be determined according to the coasting time range and the parking braking rate range of each first vehicle as well as the starting time range of each second vehicle. Thus, the control strategy of the first vehicle and the second vehicle can be adjusted according to the real-time inbound status of the vehicle. Finally, the braking of the first vehicle and the operation of the second vehicle can be respectively controlled according to the target vehicle control strategy, so as to ensure that the braking energy can be effectively absorbed and utilized.

[00103] In some embodiments, in order to fully utilize the braking energy generated by the first vehicle, determining the target vehicle control strategy may include the following steps: step 131, inputting the coasting time range and the parking braking rate range of each first vehicle as well as a target starting time range of each second vehicle matching the first vehicle into a preset optimization model, and obtaining the target vehicle control strategy corresponding to and satisfying the target braking energy absorbing power.

[00104] Here, the preset optimization model includes a target optimization function, and the target optimization function can be shown as formula (3).

$$E(x) = \sum_{i=1}^N \alpha \int_{T_s}^{T_e} P_i(t) dt \quad (3)$$

[00105] Here, N is a number of the at least one second vehicle, α is a braking energy

consumption conversion rate, T_s is a braking start time, T_e is a braking end time, and $P_i(t)$ is an absorbing braking energy power function of an i^{th} second vehicle of the at least one second vehicle.

[00106] In some embodiments, the preset optimization model may include a particle swarm algorithm, which may quickly obtain a feasible solution to meet the requirements.

[00107] In an example, during the solution of the preset optimization model, the coasting time range and the parking braking rate range of each first vehicle as well as a target starting time range of each second vehicle matching the first vehicle are randomly initialized. Further, the position of each particle involved in the calculation may be obtained, and the target optimization function as shown in formula (3) may be set at the same time. Here, the particle at each position can represent a vehicle control strategy. Next, an iterative calculation can be carried out in the preset optimization model to obtain the target vehicle control strategy satisfying the target braking energy absorbing power.

[00108] In some embodiments, in order to improve the timeliness of the calculation results, the target iteration number of the iterative calculation in the solution process can be set in advance. After the iteration number reaches the target iteration number, the maximum braking energy absorbing power in the optimization calculation process is determined according to the position of each particle, and the maximum braking energy absorbing power is determined as the target braking energy absorbing power. Further, the vehicle control strategy corresponding to the maximum braking energy absorbing power is determined as the target vehicle control strategy.

[00109] In other embodiments, the target braking energy absorbing power can be set in advance. In the process of the iterative calculation through the preset optimization model, for the iteration result of each iteration calculation, the braking energy absorption power of each particle is determined according to the position of each particle. Under a condition that the iteration result includes the target braking energy absorbing power, the iterative calculation can be stopped and the vehicle control strategy corresponding to and satisfying the target braking energy absorbing power can be directly used as the target vehicle control strategy, thus reducing the waste of computing resources and improving the vehicle regulation efficiency.

[00110] In some embodiments, within a first preset time period, under a condition that the at least one first vehicle includes a plurality of first vehicles, in the embodiments of the present

application, determining the target vehicle control strategy may include the following steps: determining, according to a preset matching condition, M matching schemes for the first vehicle and the second vehicle, wherein M is an integer greater than 1; for each matching scheme, determining, according to the coasting time range and the parking braking rate range of each first vehicle as well as the starting time range of each second vehicle, a first control strategy of the matching scheme and a first braking energy absorbing power corresponding to the first control strategy; determining a highest first braking energy absorbing power as the target braking energy absorbing power, and determining the first control strategy corresponding to the highest first braking energy absorbing power as the target vehicle control strategy.

[00111] For example, a power network region may cover multiple stations, so that within the first preset period, there may be a plurality of first vehicles satisfying the braking condition and a plurality of second vehicles satisfying the starting condition. The preset matching condition can be a one-to-one match between the braking vehicle and the towed vehicle, or a one-to-multiple match between the braking vehicle and the towed vehicles.

[00112] Fig. 3 is a schematic diagram of a vehicle operation condition provided by an embodiment of the present application. Here, station A and station B are located in the power network region. Curves 301, 302, 303, and 304 represent the velocity curves of vehicles A, B, C, and D, respectively. Here, vehicles A and D are vehicles about to enter the station, and vehicles B and C are vehicles about to leave the station.

[00113] As a specific example, under a condition that the vehicle A is the first vehicle satisfying the braking condition, the vehicle A may be matched to the second vehicle satisfying the starting condition. For example, under a condition that both the vehicles B and C satisfy the starting condition, the vehicle A may be matched to the vehicles B and C. That is, the vehicle A may tow only one of the vehicles B and C, or the vehicle A may also tow both the vehicles B and C. Accordingly, the matching scheme can be obtained including but not limited to the followings: (1) A-B; (2) A-C; (3) A-BC.

[00114] As another specific example, under a condition that after the vehicle A is detected as the first vehicle satisfying the braking condition, the vehicle A is not matched within the first preset time period, and the vehicle D is detected as satisfying the braking condition, the matching scheme is re-determined to find a better vehicle control strategy. For example, the matching

scheme may include, but is not limited to the followings: (1) AD-BC; (2) A-B, D-C; (3) A-C, B-D; and (4) A-BC, D-BC.

[00115] In order to improve the utilization rate of the braking energy, for each matching scheme, according to the coasting time range and the parking braking rate range of each first vehicle as well as the starting time range of each second vehicle, the first control strategy of the matching scheme and the first braking energy absorbing power corresponding to the first control strategy can be determined. Here, the first control strategy of the matching scheme and the first braking energy absorbing power corresponding to the first control strategy can be calculated by reference to step 131 of the embodiments of the present application, which is not repeated here.

[00116] After the first control strategy of each matching scheme and the first braking energy absorbing power corresponding to each first control strategy are calculated and obtained, the highest first braking energy absorbing power can be determined as the target braking energy absorbing power, and the first control strategy corresponding to the highest first braking energy absorbing power can be determined as the target vehicle control strategy. In this way, the actual vehicle operation situation can be effectively considered, and the recovery and utilization efficiency of the braking energy can be improved as far as possible.

[00117] In some embodiments, in order to avoid wasting computing resources, for cases where multiple matching schemes exist, the number of the matching schemes can be reduced by setting the preset matching condition. Specifically, the preset matching condition includes a first matching condition and a second matching condition, the first matching condition is that in each matching scheme, a number of the first vehicles is less than or equal to a number of the second vehicles, and the number of the first vehicles is greater than or equal to half of the number of the second vehicles; the second matching condition is that under a condition that the number of the first vehicles is greater than the number of the second vehicles, according to distances each between one of the first vehicles and one of the second vehicles, the number of the second vehicles in the matching scheme is determined from a smallest distance to a largest distance, so that the matching scheme satisfies the first matching condition.

[00118] Thus, for the cases where multiple matching schemes exist, the number of the matching schemes can be reduced, the calculation of unnecessary matching schemes can be reduced, and the computing resources can be saved.

[00119] In some embodiments, in order to ensure the operation safety of the vehicle and avoid accidents, in the process of controlling the operation of the first vehicle and the second vehicle according to the target vehicle control strategy, according to the target vehicle control strategy, the target starting time of the second vehicle can be adjusted, and the control authority may be determined. Specifically, under a condition that a time difference between the target starting time of the second vehicle and a preset starting time of the second vehicle is less than a preset time threshold, the first vehicle is controlled to brake and the second vehicle is controlled to start according to the target vehicle control strategy.

[00120] Under a condition that the time difference between the target starting time of the second vehicle and the preset starting time of the second vehicle is greater than or equal to the preset time threshold, the target vehicle control policy is transmitted to a vehicle control management platform for the vehicle control management platform generating a target instruction. Under a condition that the target instruction is received, the first vehicle is controlled to brake and the second vehicle is controlled to start respectively according to the target vehicle control strategy.

[00121] For example, the vehicle control management platform includes the Automatic Train Supervision (ATS). In the specific application process, under a condition that the time difference between the target starting time of the second vehicle and the preset starting time of the second vehicle is less than the preset time threshold, the second vehicle can be controlled directly in accordance with the target control strategy, thus reducing the delay of information transmission to be caused by reporting to the ATS, improving the timeliness of the target vehicle control strategy, and avoiding the reduction of the utilization rate of braking energy. Under a condition that the time difference between the target starting time of the second vehicle and the preset starting time of the second vehicle is greater than or equal to the preset time threshold, it is necessary to report to the ATS. After the ATS issues the target instruction, the first vehicle can be controlled to brake and the second vehicle can be controlled to operate respectively, here, the target instruction can be an agreement to use the target vehicle control strategy. Here, the transmission form of the target instruction is not specifically limited here. Thus, the vehicle control method determined according to the embodiments of the present application can effectively improve the efficiency of the recovery and utilization of the braking energy without affecting the driving safety, efficiency and service quality of the vehicle.

[00122] Fig. 4 is a schematic structural diagram of a vehicle control apparatus provided by an embodiment of the present application. As shown in Fig. 4, the vehicle control apparatus 400 may include a processing module 410, a data acquisition module 420, and a control module 430.

[00123] The processing module is configured for determining at least one first vehicle included in a first network and satisfying a braking condition;

[00124] The data acquisition module is configured for determining at least one second vehicle matching the at least one first vehicle in the first network, wherein the first network is a power network of a region where the first vehicle is located, and the second vehicle is a vehicle satisfying a starting condition within the first network;

[00125] The processing module is further configured for determining, according to a coasting time range and a parking braking rate range of each first vehicle as well as a starting time range of each second vehicle, a target vehicle control strategy corresponding to and satisfying a target braking energy absorbing power;

[00126] The control module is configured for controlling operation of the first vehicle and the second vehicle respectively according to the target vehicle control strategy.

[00127] According to the embodiments of the present application, for a same power network region, the first vehicle satisfying the braking condition may be firstly determined, then, the first vehicle may be matched to the second vehicle satisfying the starting condition. Then, the target vehicle control strategy corresponding to and satisfying the target braking energy absorbing power may be determined according to the coasting time range and the parking braking rate range of each first vehicle as well as the starting time range of each second vehicle. Thus, the control strategy of the first vehicle and the second vehicle can be adjusted according to the real-time arrival status of the vehicle. Finally, the braking of the first vehicle and the operation of the second vehicle can be respectively controlled according to the target vehicle control strategy, so as to ensure that the braking energy can be effectively absorbed and utilized.

[00128] In some embodiments, the data acquisition module 420 is further configured for acquiring in real time operation information of the first vehicle in the first network, wherein the operation information includes a preset parking braking rate of the first vehicle, a distance between the first vehicle and a preset parking point, and a first speed of the first vehicle;

[00129] the processing module 410 is further configured for determining, according to the preset

parking braking rate of the first vehicle and the distance between the first vehicle and the preset parking point, a second speed of the first vehicle that enables the first vehicle to arrive at the preset parking point;

[00130] the processing module 410 is further configured for determining, under a condition that a difference between the first speed and the second speed is less than a preset speed threshold, that the first vehicle satisfies the braking condition.

[00131] In some embodiments, the data acquisition module 420 is further configured for determining at least one third vehicle parked at a platform in the first network and acquiring in real time platform parking information of each third vehicle, wherein the platform parking information includes a parking duration of the third vehicle and a preset parking duration of the third vehicle;

[00132] the processing module 410 is further configured for determining, under a condition that a difference between the parking duration of the third vehicle and the preset parking duration of the third vehicle is less than or equal to a preset time threshold, the third vehicle as the second vehicle.

[00133] In some embodiments, the processing module 410 is further configured for inputting the coasting time range and the parking braking rate range of each first vehicle as well as a target starting time range of each second vehicle matching the first vehicle into a preset optimization model, and obtaining the target vehicle control strategy corresponding to and satisfying the target braking energy absorbing power;

[00134] wherein the preset optimization model includes a target optimization function, and the target optimization function is:

$$E(x) = \sum_{i=1}^N \alpha \int_{T_s}^{T_e} P_i(t) dt$$

[00135] wherein N is a number of the at least one second vehicle, α is a braking energy consumption conversion rate, T_s is a braking start time, T_e is a braking end time, and $P_i(t)$ is an absorbing braking energy power function of an i^{th} second vehicle of the at least one second vehicle.

[00136] In some embodiments, within a first preset time period, under a condition that the at least one first vehicle includes a plurality of first vehicles, the processing module 410 is further

configured for determining, according to a preset matching condition, M matching schemes for the first vehicle and the second vehicle, wherein M is an integer greater than 1;

[00137] the processing module 410 is further configured for determining, for each matching scheme and according to the coasting time range and the parking braking rate range of each first vehicle as well as the target starting time range of each second vehicle, a first control strategy of the matching scheme and a first braking energy absorbing power corresponding to the first control strategy;

[00138] the processing module 410 is further configured for determining a highest first braking energy absorbing power as the target braking energy absorbing power, and determining the first control strategy corresponding to the highest first braking energy absorbing power as the target vehicle control strategy.

[00139] In some embodiments, the preset matching condition includes a first matching condition and a second matching condition;

[00140] the first matching condition is that in each matching scheme, a number of the first vehicles is less than or equal to a number of the second vehicles, and the number of the first vehicles is greater than or equal to half of the number of the second vehicles;

[00141] the second matching condition is that under a condition that the number of the first vehicles is greater than the number of the second vehicles, according to distances each between one of the first vehicles and one of the second vehicles, the number of the second vehicles in the matching scheme is determined from a smallest distance to a largest distance, so that the matching scheme satisfies the first matching condition.

[00142] In some embodiments, the vehicle control apparatus 400 further comprises a transmission module;

[00143] the control module 430 is further configured for controlling, under a condition that a time difference between the target starting time of the second vehicle and a preset starting time of the second vehicle is less than a preset time threshold, the first vehicle to brake and the second vehicle to start according to the target vehicle control strategy;

[00144] the transmission module is configured for transmitting, under a condition that the time difference between the target starting time of the second vehicle and the preset starting time of the second vehicle is greater than or equal to the preset time threshold, the target vehicle control

policy to a vehicle control management platform for the vehicle control management platform generating a target instruction;

[00145] the control module 430 is further configured for controlling, under a condition that the target instruction is received, the operation of the first vehicle and the second vehicle respectively according to the target vehicle control strategy.

[00146] It can be understood that the vehicle control apparatus 400 of the embodiments of the present application may correspond to the execution subject of the vehicle control method described in the embodiments of the present application. Details of the operation and/or functions of various modules/units of the vehicle control apparatus 400 may refer to the description of the corresponding parts of the vehicle control method provided in the embodiments of the present application, which will not be repeated for simplicity.

[00147] The vehicle control apparatus of the embodiments of the present application can effectively improve the efficiency of the recovery and utilization of the braking energy without affecting the driving safety, efficiency and service quality of the vehicle.

[00148] Fig. 5 is a schematic structural diagram of a vehicle control device provided by an embodiment of the present application. As shown in Fig. 5, the device may include a processor 501 and a memory 502 storing computer program instructions.

[00149] Specifically, the foregoing processor 501 may include a central processing unit (Central Processing Unit, CPU) or an application specific integrated circuit (Application Specific Integrated Circuit, ASIC), or may be configured as one or more integrated circuits implementing the embodiments of the present application.

[00150] The memory 502 may include a large-capacity memory for information or instructions. For example and without limitation, the memory 502 may include a hard disk drive (Hard Disk Drive, HDD), a floppy disk drive, a flash memory, an optical disk, a magneto-optical disk, a magnetic tape, or a universal serial bus (Universal Serial Bus, USB) drive, or a combination of two or more thereof. In one example, the memory 502 may include a removable or non-removable (or fixed) medium, or the memory 502 is a non-volatile solid-state memory. The memory 502 may be inside or outside the vehicle control device.

[00151] In one example, the memory 502 may be a read only memory (Read Only Memory, ROM). In one example, the ROM may be a mask-programmed ROM, a programmable ROM

(PROM), an erasable PROM (EPROM), an electrically erasable PROM (EEPROM), an electrically rewriteable ROM (EAROM), or a flash memory or a combination of two or more thereof.

[00152] The processor 501 reads and executes the computer program instructions stored in the memory 502 to implement the method described in the embodiments of the present application, and achieve the corresponding technical effects achieved by the embodiments of the present application performing the method, which is not repeated here for the sake of brevity.

[00153] In one example, the vehicle control device may further include a communication interface 503 and a bus 510. As shown in Fig. 5, the processor 501, the memory 502, and the communication interface 503 are connected through the bus 510 and achieve mutual communication with each other.

[00154] The communication interface 503 is mainly configured to achieve the communication among the various modules, apparatuses, units and/or devices in the embodiments of the present application.

[00155] The bus 510 includes hardware, software, or both, and couples the various components of the vehicle control device with each other. By way of example and not limitation, the bus may include an Accelerated Graphics Port (AGP) or other graphics buses, an Enhanced Industry Standard Architecture (EISA) bus, a Front Side Bus (FSB), a Hyper Transport (HT) interconnect, an Industry Standard Architecture (ISA) bus, an infinite bandwidth interconnect, a Low Pin Count (LPC) bus, a memory bus, a Micro Channel Architecture (MCA) bus, a Peripheral Component Interconnect (PCI) bus, a PCI-Express (PCI-X) bus, a Serial Advanced Technology Attachment (SATA) bus, a Video Electronics Standards Association Local Bus (VLB) bus, or other suitable buses, or a combination thereof. When appropriate, the bus 510 may include one or more buses. Although specific buses are described and illustrated in the embodiments of the present application, the present application contemplates any suitable bus or interconnect.

[00156] The vehicle control device may perform the vehicle control method in the embodiments of the present application, thereby implementing the corresponding technical effect of the vehicle control method described in the embodiments of the present application.

[00157] In addition, the embodiments of the present application may provide a readable storage medium for implementing the vehicle control method in the above embodiments. The readable

storage medium stores computer program instructions thereon, the computer program instructions, when executed by the processor, perform any of the vehicle control methods in the above embodiments. An example of the readable storage medium includes non-transitory machine readable media such as an electronic circuit, a semiconductor memory device, a read-only memory (ROM), a floppy disk, a compact disc read-only memory (CD-ROM), an optical disk, a hard disk and the like.

[00158] It should be noted that, the present application is not limited to the specific configurations and processes described above and shown in the drawings. For simplicity, detailed description of well-known methods is omitted herein. In the above embodiments, several specific steps are described and shown as examples. Nonetheless, the flow of the methods of the present application is not limited to the specific steps as described and shown, and those skilled in the art can make various changes, modifications and additions, or change the order of the steps, after understanding the gist of the present application.

[00159] Functional blocks shown in the above structural diagrams may be implemented as hardware, software, firmware, or a combination thereof. When implemented in hardware, the functional block may be, for example, an electronic circuit, an application specific integrated circuit (Application Specific Integrated Circuit, ASIC), a suitable firmware, a plug-in, a function card and the like. When implemented in software, the elements of the present disclosure are programs or code segments used to perform the required tasks. The programs or code segments may be stored in a machine-readable medium or transmitted over a transmission medium or a communication link via data signals carried in carriers. The “machine-readable medium” may include any medium capable of storing or transmitting information. Examples of the machine-readable medium may include an electronic circuit, a semiconductor memory device, a read-only memory (ROM), a flash memory, an erasable read only memory (EROM), a floppy disk, a compact disc read-only memory (CD-ROM), an optical disk, a hard disk, a fiber medium, a radio frequency (RF) link, and the like. The code segments may be downloaded via a computer network such as the Internet, an intranet.

[00160] It should be further noted that the exemplary embodiments described in the present application describe some methods or systems based on a series of steps or apparatuses. Nonetheless, the present application is not limited to the above order of steps, that is, the steps

may be performed in the order described in the embodiments, or in a different order from the order in the embodiments, or several steps may be performed simultaneously.

[00161] Various aspects of the present application have been described above with reference to the flowchart and/or block diagram of the method, apparatus (system), and computer program product according to the embodiments of the present application. It should be understood that each block in the flowchart and/or block diagram and a combination of blocks in the flowchart and/or block diagram can be implemented by computer program instructions. These computer program instructions may be provided to the processor of a general-purpose computer, a dedicated computer, or other programmable data processing devices to produce a machine, so that the execution of these instructions via the processor of the computer or other programmable data processing devices enables the implementation of the functions/actions specified in one or more blocks of the flowchart and/or block diagram. Such a processor may be, but not limited to, a general-purpose processor, a dedicated processor, a special application processor, or a field programmable logic circuit. It may be further understood that each block in the block diagram and/or flowchart and a combination of the blocks in the block diagram and/or flowchart may also be implemented by dedicated hardware that performs the specified function or action, or may be implemented by a combination of dedicated hardware and computer instructions.

[00162] The above are merely specific implementations of the present application, and those skilled in the art may explicitly appreciate that for convenience and conciseness of the descriptions, the specific working process of the above systems, modules and units may refer to corresponding processes in the forgoing method embodiments, which will not be repeated herein. It should be understood that the scope of protection of the present application is not limited thereto, and any of those skilled in the art can easily think of various equivalent modifications or substitutions within the technical scope disclosed in the present application, and all these modifications or substitutions should be encompassed within the scope of protection of the present application.

What is claimed is:

1. A vehicle control method, comprising:

determining at least one first vehicle included in a first network and satisfying a braking condition;

determining at least one second vehicle matching the at least one first vehicle in the first network, wherein the first network is a power network of a region where the first vehicle is located, and the second vehicle is a vehicle satisfying a starting condition within the first network;

determining, according to a coasting time range and a parking braking rate range of each first vehicle as well as a starting time range of each second vehicle, a target vehicle control strategy corresponding to and satisfying a target braking energy absorbing power;

controlling operation of the first vehicle and the second vehicle respectively according to the target vehicle control strategy.

2. The method according to claim 1, wherein determining the at least one first vehicle included in the first network and satisfying the braking condition comprises:

acquiring in real time operation information of the first vehicle in the first network, wherein the operation information includes a preset parking braking rate of the first vehicle, a distance between the first vehicle and a preset parking point, and a first speed of the first vehicle;

determining, according to the preset parking braking rate of the first vehicle and the distance between the first vehicle and the preset parking point, a second speed of the first vehicle that enables the first vehicle to arrive at the preset parking point;

determining, under a condition that a difference between the first speed and the second speed is less than a preset speed threshold, that the first vehicle satisfies the braking condition.

3. The method according to claim 1, wherein determining the at least one second vehicle matching the at least one first vehicle in the first network comprises:

determining at least one third vehicle parked at a platform in the first network and acquiring in real time platform parking information of each third vehicle, wherein the platform parking

information includes a parking duration of the third vehicle and a preset parking duration of the third vehicle;

determining, under a condition that a difference between the parking duration of the third vehicle and the preset parking duration of the third vehicle is less than or equal to a preset time threshold, the third vehicle as the second vehicle.

4. The method according to claim 1, wherein determining, according to the coasting time range and the parking braking rate range of each first vehicle as well as the starting time range of each second vehicle, the target vehicle control strategy corresponding to and satisfying the target braking energy absorbing power comprises:

inputting the coasting time range and the parking braking rate range of each first vehicle as well as a target starting time range of each second vehicle matching the first vehicle into a preset optimization model, and obtaining the target vehicle control strategy matching and satisfying the target braking energy absorbing power, wherein the preset optimization model includes a target optimization function, and the target optimization function is:

$$E(x) = \sum_{i=1}^N \alpha \int_{T_s}^{T_e} P_i(t) dt$$

wherein N is a number of the at least one second vehicle, α is a braking energy consumption conversion rate, T_s is a braking start time, T_e is a braking end time, and $P_i(t)$ is an absorbing braking energy power function of an i^{th} second vehicle of the at least one second vehicle.

5. The method according to claim 1, wherein within a first preset time period, under a condition that the at least one first vehicle includes a plurality of first vehicles, determining, according to the coasting time range and the parking braking rate range of each first vehicle as well as the starting time range of each second vehicle, the target vehicle control strategy corresponding to and satisfying the target braking energy absorbing power comprises:

determining, according to a preset matching condition, M matching schemes for the first vehicle and the second vehicle, wherein M is an integer greater than 1;

for each matching scheme, determining, according to the coasting time range and the parking braking rate range of each first vehicle as well as the target starting time range of each

second vehicle, a first control strategy of the matching scheme and a first braking energy absorbing power corresponding to the first control strategy;

determining a highest first braking energy absorbing power as the target braking energy absorbing power, and determining the first control strategy corresponding to the highest first braking energy absorbing power as the target vehicle control strategy.

6. The method according to claim 5, wherein the preset matching condition includes a first matching condition and a second matching condition, the first matching condition is that in each matching scheme, a number of the first vehicles is less than or equal to a number of the second vehicles, and the number of the first vehicles is greater than or equal to half of the number of the second vehicles;

the second matching condition is that under a condition that the number of the first vehicles is greater than the number of the second vehicles, according to distances each between one of the first vehicles and one of the second vehicles, the number of the second vehicles in the matching scheme is determined from a smallest distance to a largest distance, so that the matching scheme satisfies the first matching condition.

7. The method according to claim 1, wherein the target vehicle control strategy comprises adjusting a target starting time of the second vehicle, and controlling the operation of the first vehicle and the second vehicle respectively according to the target vehicle control strategy comprises:

controlling, under a condition that a time difference between the target starting time of the second vehicle and a preset starting time of the second vehicle is less than a preset time threshold, the first vehicle to brake and the second vehicle to start according to the target vehicle control strategy;

transmitting, under a condition that the time difference between the target starting time of the second vehicle and the preset starting time of the second vehicle is greater than or equal to the preset time threshold, the target vehicle control policy to a vehicle control management platform for the vehicle control management platform generating a target instruction;

controlling, under a condition that the target instruction is received, the operation of the first

vehicle and the second vehicle respectively according to the target vehicle control strategy.

8. A vehicle control apparatus, comprising:

a processing module configured for determining at least one first vehicle included in a first network and satisfying a braking condition;

a data acquisition module configured for determining at least one second vehicle matching the at least one first vehicle in the first network, wherein the first network is a power network of a region where the first vehicle is located, and the second vehicle is a vehicle satisfying a starting condition within the first network;

the processing module being further configured for determining, according to a coasting time range and a parking braking rate range of each first vehicle as well as a starting time range of each second vehicle, a target vehicle control strategy corresponding to and satisfying a target braking energy absorbing power;

a control module configured for controlling operation of the first vehicle and the second vehicle respectively according to the target vehicle control strategy.

9. The apparatus according to claim 8, wherein

the data acquisition module is further configured for acquiring in real time operation information of the first vehicle in the first network, wherein the operation information includes a preset parking braking rate of the first vehicle, a distance between the first vehicle and a preset parking point, and a first speed of the first vehicle;

the processing module is further configured for determining, according to the preset parking braking rate of the first vehicle and the distance between the first vehicle and the preset parking point, a second speed of the first vehicle that enables the first vehicle to arrive at the preset parking point;

the processing module is further configured for determining, under a condition that a difference between the first speed and the second speed is less than a preset speed threshold, that the first vehicle satisfies the braking condition.

10. The apparatus according to claim 8, wherein

the data acquisition module is further configured for determining at least one third vehicle parked at a platform in the first network and acquiring in real time platform parking information of each third vehicle, wherein the platform parking information includes a parking duration of the third vehicle and a preset parking duration of the third vehicle;

the processing module is further configured for determining, under a condition that a difference between the parking duration of the third vehicle and the preset parking duration of the third vehicle is less than or equal to a preset time threshold, the third vehicle as the second vehicle.

11. The apparatus according to claim 8, wherein

the processing module is further configured for inputting the coasting time range and the parking braking rate range of each first vehicle as well as a target starting time range of each second vehicle matching the first vehicle into a preset optimization model, and obtaining the target vehicle control strategy corresponding to and satisfying the target braking energy absorbing power, wherein the preset optimization model includes a target optimization function, and the target optimization function is:

$$E(x) = \sum_{i=1}^N \alpha \int_{T_s}^{T_e} P_i(t) dt$$

wherein N is a number of the at least one second vehicle, α is a braking energy consumption conversion rate, T_s is a braking start time, T_e is a braking end time, and $P_i(t)$ is an absorbing braking energy power function of an i^{th} second vehicle of the at least one second vehicle.

12. The apparatus according to claim 8, wherein

the processing module is further configured for determining, according to a preset matching condition, M matching schemes for the first vehicle and the second vehicle, wherein M is an integer greater than 1;

the processing module is further configured for determining, for each matching scheme and according to the coasting time range and the parking braking rate range of each first vehicle as well as the target starting time range of each second vehicle, a first control strategy of the matching scheme and a first braking energy absorbing power corresponding to the first control

strategy;

the processing module is further configured for determining a highest first braking energy absorbing power as the target braking energy absorbing power, and determining the first control strategy corresponding to the highest first braking energy absorbing power as the target vehicle control strategy.

13. The apparatus according to claim 12, wherein the preset matching condition includes a first matching condition and a second matching condition, the first matching condition is that in each matching scheme, a number of the first vehicles is less than or equal to a number of the second vehicles, and the number of the first vehicles is greater than or equal to half of the number of the second vehicles;

the second matching condition is that under a condition that the number of the first vehicles is greater than the number of the second vehicles, according to distances each between one of the first vehicles and one of the second vehicles, the number of the second vehicles in the matching scheme is determined from a smallest distance to a largest distance, so that the matching scheme satisfies the first matching condition.

14. The apparatus according to claim 8, wherein

the target vehicle control strategy comprises adjusting a target starting time of the second vehicle;

the control module is further configured for controlling, under a condition that a time difference between the target starting time of the second vehicle and a preset starting time of the second vehicle is less than a preset time threshold, the first vehicle to brake and the second vehicle to start according to the target vehicle control strategy;

the apparatus further comprises a transmission module configured for transmitting, under a condition that the time difference between the target starting time of the second vehicle and the preset starting time of the second vehicle is greater than or equal to the preset time threshold, the target vehicle control policy to a vehicle control management platform for the vehicle control management platform generating a target instruction;

the control module is further configured for controlling, under a condition that the target

instruction is received, the operation of the first vehicle and the second vehicle respectively according to the target vehicle control strategy.

15. A vehicle control device comprising a processor and a memory storing computer program instructions;

wherein the processor reads and executes the computer program instructions to implement the vehicle control method according to any of claims 1-7.

16. A readable storage medium having computer program instructions stored thereon, wherein the computer program instructions, when executed by a processor, implement the vehicle control method according to any of claims 1-7.