[0013]

In the above explanation of the determination of the center of gravity position based on the turning characteristics, a turning parameter indicating turning characteristics as a result of turning of the vehicle based on the steering control value is a turning radius (see r0 to r2 in Fig. 1). However, a turning curvature (= 1 / turning radius), which is a reciprocal of a turning radius, can also be used as a turning parameter indicating turning characteristics. In the present embodiment to be explained hereinafter, a case where a turning curvature (= 1 / turning ~~curvature~~ radius) is used as a turning parameter will be used as an example. Note that a turning parameter is a parameter obtained from a vehicle's running path, and is a parameter that indicates turning characteristics resulting from a steering control using a steering control value mentioned above for a vehicle. The turning parameter is calculated based on self-location data of a vehicle acquired by its after-described self-location detector.

[0014]

In the present embodiment, as shown in Fig. 2, a case where the vehicle 1 consists of a trailer 10, on which a loaded cargo 12 is loaded, and a tractor 11, which tows the trailer 10, is described as an example. The tractor is also referred to as a trailer head. Although the connected trailer 10 and tractor 11 as a whole may also be referred to as a trailer, descriptions will be made based on the configuration in which the trailer 10 and tractor 11 in the connected state comprise the vehicle 1.

[0015]

In addition, in the present embodiment, a case in which the determination of the center of gravity position is done when the above-mentioned vehicle 1 is operated in a business site such as a specific factory will be used as an example. For example, the determination of the center of gravity position is done during in-site running when a large product manufactured at the factory is loaded on the trailer 10 and shipped from the factory (or during in-site running after an arrival at the factory). In the site like this, a running speed of a large vehicle is limited to 5 km/h or less, or 10 km/h or less, etc., so the running speed can be treated as known (or, an influence to a turning radius caused by the running speed can be ignored).

[0016]

Note that, even also during running on public roads, there is a case where a running route may be predetermined and a vehicle speed may be treated as a known parameter (or its influence can be ignored) when transporting a large loaded cargo at night with traffic control and traffic management. A large loaded cargo includes, for

The accelerator pedal stroke sensor 5 is a sensor that detects an operated stroke of the accelerator pedal (a driving force request value). Similar to the steering angle sensor 4 described above, when an accelerator-by-wire system or the VSC system is used, the driving force request value and the driving force control value may not be fixed in a one-to-one relationship. There is a case, when a hybrid system is adopted, where the driving force may be generated by an internal combustion engine and a motor in response to the driving force request value, and the driving force control value may be set separately for each. If an autonomous driving system, instead of a driver, controls driving of the vehicle 1, the driver does not operate the accelerator pedal, so no driving force request value exists and the autonomous driving system determines the driving force control value to drive the vehicle 1. However, similarly here, since the driving force control value is calculated based on the driving force request value when the driving force request value exists, ~~a braking~~ the driving force control value can be obtained from ~~a braking~~ the driving force request value.

[0026]

The brake pedal stroke sensor 6 is a sensor that detects an operated stroke of the brake pedal (a braking force request value). Similar to the steering angle sensor 4 and the accelerator pedal stroke sensor 5 described above, when a brake-by-wire system, the ABS system or the VSC system is used, the braking force request value and the braking force control value may not be fixed in a one-to-one relationship. There is a case, when a hybrid system is adopted, where the braking force may be generated by a fluid pressure brake (an oil pressure brake or an air brake) and a regenerative power generation brake with respect to the braking force request value, and the braking force control value may be set separately for each. If an autonomous driving system, instead of a driver, controls driving of the vehicle 1, the driver does not operate the brake pedal, so no braking force request value exists and the autonomous driving system determines the braking force control value to run the vehicle 1. However, similarly here, since the braking force control value is calculated based on the braking force request value when the braking force request value exists, the braking force control value can be obtained from the braking force request value.

[0027]

As mentioned above, the autonomous driving system installed in the vehicle 1 is controlled by the controller 2. Therefore, various actuators for automatically controlling the steering of the steered road wheels and the driving/braking of the vehicle 1 can also be controlled by the controller 2. The controller 2 controls these actuators

CLAIMS

[Claim 1]

An apparatus for determining a center of gravity position, the apparatus comprising:

a vehicle (1) on which a cargo (12) is loadable;

a self-location detector (2, 7, 8) that acquires self-location data of the vehicle (1);

a turning parameter generator (20) that calculates a turning parameter based on the self-location data;

a steering detector (4) that detects a steering control value of the vehicle (1);

a memory (21) that stores reference data;

a comparator (22) that compares the turning parameter calculated by the turning parameter generator (20) and the steering control value detected by the steering detector (4) with the reference data; and

a determiner (23) that determines a center of gravity position of the vehicle (1) or the cargo (12) based on comparison results of the comparator (22).

[Claim 2]

The apparatus for determining the center of gravity position according to claim 1,

wherein the vehicle (1) includes a turning controller (13) that controls a turning motion, and

wherein the apparatus for determining the center of gravity position further comprises a compensator (24) that compensates an input to the turning controller (13) based on the comparison results.

[Claim 3]

The apparatus for determining the center of gravity position according to claim 1 or 2,

wherein the reference data are data that indicate relationship between the turning parameter and the steering control value when the cargo (12) is in a predetermined state.

[Claim 4]

The apparatus for determining the center of gravity position according to any one of claims 1 to 3,

wherein the reference data is created under a condition where a speed of the vehicle (1) is constant.

[Claim 5]

The apparatus for determining the center of gravity position according to any one of claims 1 to 4,

wherein the memory (21) stores a plurality of reference data corresponding to different center of gravity positions.

[Claim 6]

The apparatus for determining the center of gravity position according to any one of claims 1 to 5,

wherein the turning parameter generator (20) calculates a turning curvature or a turning radius as the turning parameter.

[Claim 7]

A method for determining a center of gravity position of a vehicle (1) on which a cargo (12) is loadable or of the cargo (12), the method comprising:

constructing relationship between a steering control value of the vehicle (1) when the cargo (12) is in a predetermined state, preliminarily;

calculating a turning parameter based on an actual self-location history of the vehicle (1) by using a self-location detection function of the vehicle (1); and

determining the center of gravity position of the vehicle (1) or the cargo (12) by comparing the steering control value used for an actual turning and the turning parameter calculated based on the self-location history with the reference data.

[Claim 8]

The method for determining the center of gravity position according to claim 7,

wherein the reference data is constructed by treating also a speed of the vehicle (1) as a parameter, and

wherein the steering control value used for the actual turning, the turning parameter calculated based on the self-location history and a detected actual speed of the vehicle (1) are compared with the reference data.

[Claim 9]

The method for determining the center of gravity position according to claim 7 or 8,

wherein the reference data is constructed during an actual running of the vehicle.