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Collision avoidance support device for a vehicle and collision avoidance support program for a vehicle

Abstract

A collision avoidance support device for a vehicle that includes an obstacle detection device for detecting an obstacle in front of the vehicle and an electronic control unit configured to perform automatic brake control that automatically applies braking force to a vehicle when it is determined that the obstacle detection device have detected an obstacle and the vehicle may collide with the obstacle, and the electronic control unit is configured to prohibit the automatic brake control when it is determined that the vehicle is not towing a trailer and a turning index value indicating a degree of turning of the vehicle is equal to or larger than a first reference value, and prohibit the automatic brake control when it is determined that the vehicle is towing a trailer and the turning index value is equal to or larger than a second reference value smaller than the first reference value.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

(1) This application claims priority to Japanese Patent Application No. JP2021-141616 filed on Aug. 31, 2021, the content of which is hereby incorporated by reference in its entirety into this application.

BACKGROUND

1. Technical Field

(2) The present disclosure relates to a collision avoidance support device for a vehicle and a collision avoidance support program for a vehicle.

2. Description of the Related Art

(3) A collision avoidance support device is known as one of driving support devices for vehicles such as automobiles. The collision avoidance support device warns a driver when an obstacle that may cause a collision is detected in front of a vehicle, and when the possibility of collision becomes higher, the collision avoidance support device executes collision avoidance support control to prevent the vehicle from colliding with the obstacle by automatic brake control.

(4) Even in a vehicle equipped with a collision avoidance support device, a driver may perform steering operations to avoid a collision with an obstacle, in which case automatic brake control needs to be restricted so that the driver's driving is prioritized. For example, Japanese Patent Application Laid-Open No. 2021-079904 describes a collision avoidance support control in which automatic brake is prohibited as steer override when a steering angle or steering angular velocity is equal to or higher than a corresponding threshold value.

(5) A vehicle such as an automobile may tow a trailer, and even in a situation where a vehicle is towing a trailer, if there is an obstacle in front of the vehicle that may cause a collision, it is conceivable to execute collision avoidance support control so that the vehicle can avoid colliding with the obstacle.

(6) However, in a situation where a vehicle is towing a trailer, if the vehicle is suddenly decelerated by automatic brake control by collision avoidance support control, the vehicle is pushed from behind by the trailer, and a jackknifing phenomenon may occur in which a crossing angle of longitudinal centerlines of the vehicle and the trailer becomes excessive.

(7) The jackknifing phenomenon also may occur at a stage where a steering angle and a steering angular velocity are smaller than corresponding threshold values of steer override. Therefore, when collision avoidance support control is performed in a situation where a vehicle is towing a trailer, even if automatic brake is prohibited when a steering angle or steering angular velocity is equal to or higher than the corresponding threshold value of steer override, the jackknifing phenomenon cannot be prevented from occurring.

SUMMARY

(8) The present disclosure provides a collision avoidance support device and a collision avoidance

support program improved so that a jackknifing phenomenon does not occur due to an automatic brake control by a collision avoidance support control in a situation where a vehicle is towing a trailer.

(9) According to the present disclosure, a collision avoidance support device for a vehicle is provided, including an obstacle detection device that detects an obstacle in front of a vehicle and an electronic control unit configured to perform automatic brake control to apply braking force automatically to the vehicle when it is determined that an obstacle is detected by the obstacle detection device and the vehicle may collide with the obstacle.

(10) The electronic control unit is configured to prohibit the automatic brake control when it is determined that the vehicle is not towing a trailer and a turning index value indicating a degree of turning of the vehicle is equal to or higher than a first reference value, and prohibit the automatic brake control when it is determined that the vehicle is towing a trailer and the turning index value is equal to or larger than a second reference value smaller than the first reference value.

(11) According to the present disclosure, a collision avoidance support program for a vehicle is provided that causes an electronic control unit mounted on a vehicle to execute a step of detecting an obstacle in front of the vehicle by an obstacle detection device and a step of performing automatic brake control that automatically applies braking force to the vehicle when it is determined that an obstacle is detected by the obstacle detection device and the vehicle may collide with the obstacle.

(12) The collision avoidance support program includes a step of determining whether the vehicle is towing a trailer, a step of prohibiting the automatic brake control when it is determined that the vehicle is not towing a trailer and a turning index value indicating a degree of turning of the vehicle is equal to or larger than a first reference value, and a step of prohibiting the automatic brake control when it is determined that the vehicle is towing a trailer and the turning index value is equal to or larger than a second reference value smaller than the first reference value.

(13) When a vehicle is towing a trailer, the larger the turning index value, the larger a hitch angle, that is, a crossing angle of longitudinal center lines of the vehicle and the trailer when viewed from above, and the larger the hitch angle, the larger the possibility that a jackknifing phenomenon is likely to occur due to the automatic brake control by the collision avoidance support control. Therefore, in order to effectively prevent an occurrence of the jackknifing phenomenon, in embodiments, automatic brake control is prohibited at a stage where the hitch angle is small, in other words, when the turning index value is small.

(14) According to the above-mentioned collision avoidance support device and collision avoidance support program, in a situation where the vehicle is not towing a trailer, the automatic brake control is prohibited when it is determined that the turning index value indicating the degree of turning of the vehicle is equal to or larger than the first reference value. On the other hand, in a situation where the vehicle is towing a trailer, the automatic brake control is prohibited when it is determined that the turning index value is equal to or larger than a second reference value, and the second reference value is smaller than the first reference value. Therefore, it is possible to effectively prevent the jackknifing phenomenon from occurring due to the automatic brake control as compared to where the automatic brake control is prohibited when it is determined that the turning index value is equal to or higher than the first reference value in a situation where the vehicle is towing a trailer.

(15) In one aspect of the present disclosure, the electronic control unit is configured to continue the prohibition of the automatic brake control until a predetermined time elapses from a time point when it is determined that the turning index value becomes equal to or smaller than a third reference value smaller than the second reference value from a value larger than the third reference value, and release the prohibition of the automatic brake control after the predetermined time has elapsed from the above time point.

(16) When a vehicle tows a trailer and turns, the trailer continues to turn for a while even if the

vehicle finishes turning, and a hitch angle does not become zero. Therefore, in embodiments the prohibition of the automatic brake control is continued for a while even if the turning index value becomes small.

(17) According to the above aspect, the prohibition of the automatic brake control is continued until a predetermined time elapses from a time point when it is determined that the turning index value becomes equal to or smaller than a third reference value smaller than the second reference value from a value larger than the third reference value, and the prohibition of the automatic brake control is released after the predetermined time has elapsed from the above time point. Therefore, in a situation where the vehicle has finished turning but the trailer is in a turning state, it is possible to prevent the jackknifing phenomenon from occurring due to the automatic brake control.

(18) In another aspect of the present disclosure, the electronic control unit is configured to variably set the predetermined time according to a vehicle speed so that the higher the vehicle speed, the shorter the predetermined time.

(19) The higher a vehicle speed, the shorter a time for a trailer to continue turning even after a vehicle finishes turning. Therefore, in embodiments the predetermined time is variably set according to the vehicle speed so that the higher the vehicle speed, the shorter the predetermined time.

(20) According to the above aspect, the predetermined time is variably set according to a vehicle speed so that the higher the vehicle speed, the shorter the predetermined time. Therefore, the prohibition of the automatic brake control can be prevented from being continued unnecessarily long when a vehicle speed is high, while preventing the automatic brake control from being restarted in spite the trailer is in a turning state when the vehicle speed is low.

(21) Further, in another aspect of the present disclosure, the turning index value is a steering angle.

(22) According to the above aspect, since the turning index value is a steering angle, it is possible to control the prohibition of the automatic brake control based on a steering angle detected as a steering operation amount of a driver.

(23) Further, in another aspect of the present disclosure, the turning index value is a yaw rate of the vehicle.

(24) According to the above aspect, it is possible to control the prohibition of the automatic brake control based on a yaw rate of the vehicle detected as one of turning state quantities of the vehicle.

(25) Further, in another aspect of the present disclosure, the turning index value is a product of a yaw rate of the vehicle and a vehicle speed.

(26) According to the above aspect, it is possible to control the prohibition of the automatic brake control based on a product of a vehicle speed of the vehicle and a yaw rate detected as one of turning state quantities of the vehicle, that is, an estimated lateral acceleration of the vehicle.

(27) Further, in another aspect of the present disclosure, the turning index value is a steering angle, and the electronic control unit is configured to continue the prohibition of the automatic brake control until a predetermined time elapses from a time point when it is determined that a condition that an absolute value of a steering angle is smaller than or equal to the third reference value smaller than the second reference value and an absolute value of a time derivative of the steering angle is smaller than or equal to a reference value of the time derivative is satisfied, and release the prohibition of the automatic brake control after the predetermined time has elapsed from the above time point.

(28) According to the above aspect, the prohibition of the automatic brake control is continued until a predetermined time elapses from a time point when it is determined that the above condition is satisfied, and the prohibition of the automatic brake control is released after the predetermined time has elapsed from the above time point.

(29) The absolute value of the time derivative of the steering angle generally becomes equal to or smaller than the reference value of the time derivative after the absolute value of the steering angle becomes equal to or smaller than the third reference value. Therefore, according to the above

aspect, as compared to where a time derivative value of a steering angle is not taken into consideration, it is possible to continue the prohibition of the automatic brake control for a longer time, and reduce the possibility that the prohibition of the automatic brake control is released before a trailer goes straight.

(30) Further, according to the above aspect, the prohibition of the automatic brake control can be continued not only when the turning of the vehicle is completed but also when the vehicle changes lanes and an absolute value of a steering angle becomes equal to or smaller than the third reference value during the lane change. Therefore, when the vehicle changes lanes, it is possible to reduce the possibility that the jackknifing phenomenon occurs due to the automatic brake control.

(31) In the present application, the “degree of turning of a vehicle” is determined to be higher as a turning radius of the vehicle is smaller and higher as a vehicle speed is higher. The turning radius of the vehicle is smaller as an absolute value of a steering angle is larger, and is smaller as an absolute value of a yaw rate of the vehicle is larger.

(32) Other objects, other features and attendant advantages of the present disclosure will be readily understood from the description of the embodiments of the present disclosure described with reference to the following drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. 1 is a schematic configuration diagram showing an embodiment of a vehicle collision avoidance support device for a vehicle according to the present disclosure.

(2) FIG. 2 is a diagram showing a situation in which a vehicle is towing a trailer and traveling straight.

(3) FIG. 3 is a diagram showing a situation in which a vehicle is towing a trailer and turning.

(4) FIG. 4 is a diagram showing a situation in which a vehicle tows a trailer and finishes turning.

(5) FIG. 5 is a flowchart showing a PCS control routine in the embodiment.

(6) FIG. 6 is a flowchart showing a non-execution control routine of an automatic brake control by the PCS control in the embodiment.

(7) FIG. 7 is a flowchart showing a non-execution control routine of the automatic brake control by the PCS control in a first modification.

(8) FIG. 8 is a flowchart showing a non-execution control routine of the automatic brake control by the PCS control in a second modification.

(9) FIG. 9 is a flowchart showing a non-execution control routine of the automatic brake control by the PCS control in a third modification.

(10) FIG. 10 is a map for calculating a reference value T_{tnc} based on a vehicle speed V .

DETAILED DESCRIPTION

(11) The embodiment of the present disclosure will now be described in detail with reference to the accompanying drawings.

(12) [Embodiment]

(13) As shown in FIG. 1, the vehicle collision avoidance support device **10** according to the embodiment is adapted to a vehicle **12** (referred to as “own vehicle” as necessary to distinguish it from other vehicles). The collision avoidance support device **10** includes a collision avoidance support ECU **20** and a brake ECU **30**, and the vehicle **12** includes an engine ECU **40** and a meter ECU **50**.

(14) These ECUs are electronic control units each having a microcomputer as a main part, and are connected to each other so as to be able to transmit and receive information via a CAN (Controller Area Network) (not shown). Although not shown in FIG. 1, the microcomputer includes a CPU, a ROM, a RAM, a non-volatile memory, an interface I/F, and the like. Each CPU realizes various

functions by executing instructions (programs, routines) stored in the ROM. Some or all of these ECUs may be integrated into one ECU.

(15) The collision avoidance support ECU **20** gives an alarm to a driver when an obstacle is detected in front of the own vehicle, and executes collision avoidance support control to prevent the own vehicle from colliding with the obstacle by automatic brake control when the possibility of collision becomes higher. Since the collision avoidance support control is generally called PCS control (pre-crash safety control), the collision avoidance support control is hereinafter called PCS control.

(16) An obstacle detection device **60**, a traveling state sensor **70**, an operation state sensor **80**, an alarm device **90**, and a traction sensor **92** are connected to the collision avoidance support ECU **20**. In the embodiment, the obstacle detection device **60** and the like are connected to the collision avoidance support ECU **20**, but at least one of them may be connected to the CAN. The alarm device **90** may be any of an alarm device that issues a visual alarm such as an alarm lamp, an alarm device that issues an auditory alarm such as an alarm buzzer, and an alarm device that issues a bodily alarm such as vibration of a seat, and may be any combination thereof.

(17) In the present embodiment, the obstacle detection device **60** includes a camera sensor **62** and a radar sensor **64**. The camera sensor **62** is arranged in the upper part of the front window in a vehicle interior, and captures scenery in front of the vehicle **12**. The camera sensor **62** recognizes a white line on a road and a three-dimensional object existing in front of the vehicle **12** based on the captured image, and supplies the information (white line information, three-dimensional object information) to the collision avoidance support ECU **20** at a predetermined cycle. The white line information is information indicating a shape of the white line and a relative positional relationship between the vehicle **12** and the white line. The three-dimensional object information is information indicating a type of the three-dimensional object detected in front of the vehicle **12**, a size of the three-dimensional object, a relative positional relationship of the three-dimensional object with respect to the vehicle, and the like. The recognition of the type of a three-dimensional object is realized by machine learning such as pattern matching, for example.

(18) The radar sensor **64** is provided in the center of the front of a vehicle body and detects a three-dimensional object existing in the front region of the vehicle **12**. The radar sensor **64** emits radio waves in the millimeter wave band (hereinafter referred to as “millimeter wave”) and receives millimeter waves (that is, reflected waves) reflected by a three-dimensional object (for example, another vehicle, pedestrian, bicycle, building, etc.) existing in a radiation range. The radar sensor **64** calculates a distance between the vehicle **12** and a three-dimensional object, a relative speed of the vehicle with respect to the three-dimensional object, a relative position (direction) of the three-dimensional object with respect to the vehicle, and the like based on a phase difference between the transmitted millimeter wave and the received reflected wave, an attenuation level of the reflected wave, a time from the transmission of the millimeter wave to the reception of the reflected wave, and the like, and supplies information (three-dimensional object information) representing calculation results to the collision avoidance support ECU **20** at a predetermined cycle.

(19) The collision avoidance support ECU **20** synthesizes the three-dimensional object information supplied from the camera sensor **62** and the three-dimensional object information supplied from the radar sensor **64** to acquire highly accurate three-dimensional object information. Therefore, the camera sensor **62** and the radar sensor **64** function as an obstacle detection device **60** for detecting an obstacle in front of the vehicle **12**.

(20) The traveling state sensor **70** is, for example, a wheel speed sensor that detects a wheel speed of each wheel of the vehicle **12**, a longitudinal acceleration sensor that detects a longitudinal acceleration of the vehicle, a lateral acceleration sensor that detects a lateral acceleration of the vehicle, and a yaw rate sensor that detects a yaw rate Y_r of the vehicle. The yaw rate Y_r becomes a positive value when the vehicle **12** turns to the left.

(21) The operation state sensor **80** is a sensor and a switch for detecting an operation performed by

the driver. Although not shown in FIG. 1, the operation state sensor **80** includes an accelerator operation amount sensor that detects an amount of depression of an accelerator pedal (accelerator opening), and a brake operation amount sensor that detects a depression force on a brake pedal or a master cylinder pressure. Further, the operation state sensor **80** includes a steering angle sensor that detects a steering angle θ corresponding to a steering operation amount, a steering torque sensor that detects a steering torque, a blinker switch that detects an operating state of a blinker, and a shift position sensor that detects a shift position of a transmission and the like. The steering angle θ becomes a positive value when the vehicle **12** turns to the left.

(22) As shown in FIGS. 2 to 4, a front end bracket **102B** of a trailer **102** can be connected to a rear end bracket **12B** of the vehicle **12** by a joint **100**. Therefore, the vehicle **12** functions as a tractor for towing the trailer **102** as needed. In FIGS. 2 to 4, a hitch angle ϕ , that is, an intersection angle of longitudinal center lines **12A** and **102A** of the vehicle **12** and the trailer **102** seen from above is shown. The hitch angle ϕ becomes a positive value when the vehicle **12** turns to the left.

(23) As shown in FIG. 2, when the vehicle **12** and the trailer **102** are in the straight-ahead state, the longitudinal center line **12A** of the vehicle **12** and the longitudinal center line **102A** of the trailer **102** are aligned with each other, and a center of the joint **100** is located on these longitudinal centerlines. On the other hand, as shown in FIG. 3, when the vehicle **12** and the trailer **102** are in a turning state, the longitudinal center line **12A** of the vehicle **12** and the longitudinal center line **102A** of the trailer **102** intersect each other and the center of the joint **100** is located on an intersection of these longitudinal centerlines.

(24) A brake ECU **104** is mounted on the trailer **102**, and a brake ECU **104** is configured to be electrically connected to the collision avoidance support ECU **20** via a connector **106** and the CAN (not shown) as shown in FIG. 1. The traction sensor **92** may be a switch that turns on when the collision avoidance support ECU **20** and the brake ECU **104** are electrically connected by the connector **106**.

(25) Information (referred to as sensor information) detected by the traveling state sensor **70**, the operation state sensor **80**, and the traction sensor **92** is supplied to the collision avoidance support ECU **20** at a predetermined cycle via the CAN (not shown).

(26) A brake actuator **32** is connected to the brake ECU **30**. The brake actuator **32** is provided in the hydraulic circuit between a master cylinder (not shown) that pressurizes hydraulic oil by a pedaling force applied to a brake pedal (not shown) and friction brake mechanisms **34** provided on the left and right front wheels **14FL** and **14FR** and the left and right rear wheels **14RL** and **14RR**. Each friction brake mechanism **34** includes a brake disc **34a** that rotates with the corresponding wheel and a brake caliper **34b** supported by a vehicle body (not shown). The brake actuator **32** adjusts a hydraulic pressure supplied to a wheel cylinder built in each brake caliper **34b** in response to an instruction from the brake ECU **30**, and the hydraulic pressure presses brake pads (not shown) against the brake disc **34a** to generate a frictional braking force.

(27) The brake ECU **30** calculates a driver-required deceleration based on a pedal effort or a master cylinder pressure detected by the brake operation amount sensor, and controls the operation of the brake actuator **32** so that the vehicle **12** decelerates at the driver-required deceleration. Further, when the brake ECU **30** receives a PCS brake command from the collision avoidance support ECU **20**, the brake ECU **30** controls the operation of the brake actuator **32** so that the vehicle **12** decelerates at a PCS required deceleration which is an information included in the PCS brake command.

(28) When the brake pedal is operated by the driver in a situation where the brake ECU **30** is receiving the PCS brake command, the brake ECU **30** adopts a required deceleration having a larger absolute value among the driver-required deceleration and the PCS-required deceleration as a final required deceleration. The brake ECU **30** controls the operation of the brake actuator **32** so that the vehicle **12** decelerates at the final required deceleration. That is, the brake ECU **30** executes a brake override control.

(29) The brake ECU **30** performs anti-skid control (hereinafter referred to as “ABS control”) in a manner known in the art. That is, the brake ECU **30** calculates braking slip rates of the wheels based on the wheel speeds V_{wi} ($i=fl, fr, rl$ and rr) of the left and right front wheels **14FL** and **14FR** and the left and right rear wheels **14RL** and **14RR** detected by the wheel speed sensors included in the traveling state sensor **70**. Further, when the braking slip ratio of any of the wheels exceeds a control start reference value, the brake ECU **30** controls the braking force of the wheel so that the braking slip ratio of the wheel is within a predetermined range until a preset control end condition is satisfied.

(30) A brake actuator **108** is connected to the brake ECU **104**. The brake actuator **108** is provided in a hydraulic circuit between a hydraulic source (not shown) for supplying high-pressure hydraulic oil and friction brake mechanisms **112** provided on a left wheel **110L** and a right wheel **110R**. Each friction brake mechanism **112** is configured in the same manner as the friction brake mechanism **34**, and is controlled by the brake ECU **104** so that a frictional braking force corresponding to the driver required deceleration or the PCS required deceleration is generated.

(31) An engine actuator **42** is connected to the engine ECU **40**. The engine actuator **42** is an actuator for changing an operating state of an engine **44** (internal combustion engine), and includes, for example, a throttle valve actuator for changing an opening degree of a throttle valve. The engine ECU **40** calculates a driver-required driving force based on an amount of depression of an accelerator pedal detected by an accelerator operation amount sensor, and controls an operation of the engine actuator **42** so that a driving force (actual driving force) of the vehicle **12** approaches the driver-required driving force.

(32) When the engine ECU **40** receives a driving force limiting command from the collision avoidance support ECU **20**, the engine ECU controls the operation of the engine actuator **42** so as to suppress an output torque (driving force of the vehicle **12**) generated by the engine **44**. Notably, when the vehicle is an electric vehicle, the engine actuator **42** is a drive device for an electric motor, and when the vehicle is a hybrid vehicle, the engine actuator **42** is a drive device for an engine actuator and an electric motor.

(33) A display **52** and a brake lamp **54** are connected to the meter ECU **50**. The meter ECU **50** displays information related to the collision avoidance support on the display **52** according to the display command from the collision avoidance support ECU **20**. The display **52** may be, for example, a head-up display or a multi-information display for displaying meters and various information.

(34) <PCS Control>

(35) Next, PCS control will be described. The collision avoidance support ECU **20** determines the possibility that the own vehicle **12** collides with a three-dimensional object in front of the vehicle based on the information about the three-dimensional object supplied from the obstacle detection device **60** and a vehicle state detected by the traveling state sensor **70**. For example, the collision avoidance support ECU **20** determines if there is a possibility of collision with a three-dimensional object when the object maintains a current moving state (when the three-dimensional object is a stationary object, a stopped state) and the own vehicle maintains a current running state. When the collision avoidance support ECU **20** determines that the own vehicle may collide with the three-dimensional object, the collision avoidance support ECU recognizes the three-dimensional object as an obstacle.

(36) When the collision avoidance support ECU **20** detects an obstacle, the collision avoidance support ECU calculates a collision prediction time TTC, which is a predicted time until the own vehicle **12** collides with the obstacle. The collision prediction time TTC is calculated by the following equation (1) based on a distance D_r between the obstacle and the own vehicle and a relative speed V_r of the own vehicle with respect to the obstacle. The collision prediction time TTC is an index showing a high possibility that the own vehicle collides with an obstacle, and the smaller the value, the higher the possibility (risk) that the own vehicle collides with the obstacle.

$$TTC = Dr/Vr \quad (1)$$

(37) In the PCS control of the present embodiment, a level of possibility that the own vehicle **12** collides with an obstacle is divided into two stages based on the collision prediction time TTC. When the collision prediction time TTC drops below a warning threshold TTCw (a positive constant), the collision avoidance support ECU **20** determines that the level of the possibility that the own vehicle collides with the obstacle has reached a first stage, and uses the display **52** and the alarm device **90** to give alarms to a driver.

(38) When the collision prediction time TTC further decreases and becomes equal to or smaller than an operating threshold TTCa (a positive constant smaller than TTCw), the collision avoidance support ECU **20** determines that the level of the possibility that the own vehicle **12** collides with the obstacle has reached a second stage, and starts an automatic brake control. In this connection, the collision avoidance support ECU **20** transmits a PCS brake command to the brake ECU **30**. The PCS brake command contains information representing a PCS required deceleration Gpcs.

(39) The PCS request deceleration Gpcs is calculated as follows. For example, taking a case where an obstacle is stopped, and representing a speed (=relative speed) of the own vehicle at a present time by V, a deceleration of the own vehicle by Gb (<0), and a time until the own vehicle stops by t, a mileage X until the own vehicle stops can be expressed by the following equation (2).

$$X = V \cdot t - \frac{1}{2} G_b \cdot t^2 \quad (2)$$

(40) Further, the time t until the own vehicle stops can be expressed by the following equation (3).

$$t = -V/G_b \quad (3)$$

(41) Therefore, by substituting the time t represented by the equation (3) into the time t of the equation (2), the mileage X until the own vehicle stops can be expressed by the following equation (4).

$$X = -V \cdot \sup.2 / (2G_b) \quad (4)$$

(42) In order to stop the vehicle in front of the obstacle by a distance β, the deceleration Gb may be calculated by setting the mileage X to a distance (Ds-β) obtained by subtracting the distance β (>0) from a distance Ds detected by the obstacle detection device **60**. Notably, when an obstacle is traveling, the mileage X may be calculated using a relative speed and a relative deceleration with the obstacle.

(43) The PCS required deceleration Gpcs is set to a sign inversion value of the deceleration Gb calculated in the above way. An upper limit value Gmax (>0) is set for the PCS request deceleration Gpcs, and if the calculated magnitude (absolute value) of the PCS request deceleration Gpcs exceeds the upper limit value Gmax, the magnitude of the deceleration Gpcs is set to the upper limit Gmax.

(44) Upon receiving the PCS brake command, the brake ECU **30** controls the brake actuator **32** so that a deceleration of the own vehicle **12** becomes the PCS required deceleration Gpcs. As a result, frictional braking forces are generated on the front and rear wheels without requiring the driver to operate the brake pedal, and the own vehicle can be forcibly decelerated. As described above, the automatic brake control is a control in which friction braking forces are generated on the front and rear wheels by a PCS brake command to decelerate the own vehicle. Notably, when the vehicle tows a trailer, frictional braking forces may be generated on the left and right wheels of the trailer by a PCS brake command to decelerate the trailer.

(45) The collision avoidance support ECU **20** determines whether or not the collision prediction time TTC becomes larger than an end threshold value TTCb (a positive constant larger than TTCw) by the automatic brake control. Since the end threshold TTCb is larger than TTCw, it is a value larger than the operating threshold TTCa. Therefore, the collision avoidance support ECU **20** monitors whether or not the possibility of collision between the own vehicle **12** and the obstacle is low (whether or not the collision can be avoided). When the collision avoidance support ECU **20** determines that the possibility of collision between the own vehicle and the obstacle is low, the collision avoidance support ECU terminates the transmission of the PCS brake command. As a

result, the automatic brake control terminates and the PCS control terminates. Further, the collision avoidance support ECU **20** terminates the transmission of the PCS brake command when the own vehicle is stopped by the automatic brake control. As a result, the automatic brake control terminates.

(46) The collision avoidance support ECU **20** transmits a stop holding command to the brake ECU **30** after the automatic brake control is completed. While receiving the stop holding command, the brake ECU **30** controls the brake actuator **32** to supply a hydraulic pressure set for a stop holding to the wheel cylinders of the friction brake mechanism **34** of the left and right front and rear wheels. As a result, a stopped state of the own vehicle is maintained so that the own vehicle does not move forward or backward (stop holding control). The collision avoidance support ECU **20** stops the transmission of the stop holding command when a cancellation condition of the stop holding control is satisfied. Thus, the supply of the hydraulic pressure to each wheel cylinder is terminated, and the stop holding state of the own vehicle is released.

(47) The release condition of the stop holding control is satisfied when either a release condition 1 or a release condition 2 is satisfied. For example, the release condition 1 is that a duration of the stop holding state of the own vehicle reaches a set time, and the release condition 2 is that a depressing operation of the brake pedal is detected.

(48) The collision avoidance support ECU **20** terminates a driving force limit command for limiting an engine output torque (for example, making the engine output torque zero) to the engine ECU **40** while the automatic brake control is being executed and the own vehicle is held in the stopped state. Therefore, even if the driver operates an accelerator pedal while the automatic brake control is being executed, a driving force required by the driver is ignored, and the own vehicle does not accelerate according to the accelerator pedal operation. The control for holding the own vehicle in the stopped state is referred to as a stop holding control.

(49) <PCS Control Routine>

(50) Next, the PCS control routine in the embodiment will be described with reference to the flowchart shown in FIG. 5. The control according to the flowchart shown in FIG. 5 is repeatedly executed by the CPU of the collision avoidance support ECU **20** at predetermined time intervals when an ignition switch (not shown) is on.

(51) First, in step **S10**, the CPU determines whether or not the obstacle detection device **60** has detected an obstacle in front of the vehicle **12**. When a negative determination is made, the CPU temporarily terminates the PCS control, and when an affirmative determination is made, in step **S20** the CPU calculates a collision prediction time TTC as described above.

(52) In step **S30**, the CPU determines whether or not a flag Fpcs is 1, that is, whether or not the automatic brake control by the PCS control is being executed. When an affirmative determination is made, the CPU advances the PCS control to step **S110**, and when a negative determination is made, the CPU advances the PCS control to step **S40**. The flag Fpcs is initialized to 0 prior to step **S10** at the start of control according to the flowchart shown in FIG. 5.

(53) In step **S40**, the CPU determines whether or not the collision prediction time TTC is equal to or smaller than the alarm threshold value TTCw, that is, whether or not it is necessary to generate an alarm. When a negative determination is made, the CPU temporarily terminates the PCS control, and when an affirmative determination is made, in step **S50** the CPU activates the alarm device **90** to generate an alarm that the vehicle may collide with the obstacle.

(54) In step **S60**, the CPU determines whether or not a flag Fnp is 1, that is, whether or not the execution of the automatic brake control by the PCS control is prohibited in a situation where the vehicle **12** is not towing a trailer. When an affirmative determination is made, the CPU temporarily terminates the PCS control, and when a negative determination is made, the CPU advances the PCS control to step **S65**. When an affirmative determination is made in this step or in step **S65** described later, step **S100** described later is not executed. Therefore, if the automatic brake control by PCS control has already been executed, the automatic brake control is finished.

(55) In step **S65**, the CPU determines whether or not the flag **Ftnp** is 1, that is, whether or not the execution of the automatic brake control by the PCS control is prohibited in the situation where the vehicle **12** is towing a trailer. When an affirmative determination is made, the CPU temporarily terminates the PCS control, and when a negative determination is made, the CPU advances the PCS control to step **S70**.

(56) In step **S70**, the CPU determines whether or not the collision prediction time **TTC** is equal to or smaller than the operating threshold value **TTCa**, that is, whether or not the automatic brake control is necessary. When a negative determination is made, the CPU temporarily terminates the PCS control, and when an affirmative determination is made, in step **S80** the CPU sets the flag **Fpcs** to 1.

(57) In step **S90**, the CPU calculates a PCS required deceleration **Gpcs** as described above, and in step **S100**, the CPU issues a PCS brake command to the brake ECU **30** to change a deceleration of the vehicle **12** to the PCS required deceleration **Gpcs**. Therefore, the brake actuator **32** is controlled by the brake ECU **30** so that the deceleration of the vehicle **12** becomes the PCS required deceleration **Gpcs**. Further, the CPU displays on the display **52** that the automatic brake control is being executed.

(58) In step **S110**, the CPU determines whether or not the collision prediction time **TTC** is larger than the end threshold value **TTCb**. When a negative determination is made, the CPU advances the PCS control to step **S90**, and when an affirmative determination is made, the CPU advances the PCS control to step **S120**.

(59) In step **S120**, the CPU releases the automatic brake control and displays on the display **52** that the automatic brake control has been released, and in step **S130**, the CPU executes the stop holding control as described above. If the automatic brake control is already released, step **S120** is skipped.

(60) In step **S140**, the CPU determines whether or not the above-mentioned release condition 1 or 2 of the stop holding control is satisfied. When a negative determination is made, the CPU temporarily terminates the PCS control, and when an affirmative determination is made, the CPU resets the flag **Fpcs** to 0 in step **S150**, releases the alarm and the stop holding control in step **S160**, and displays on the display **52** that the stop holding control has been released.

(61) <Non-Execution Control Routine of Automatic Brake Control>

(62) Next, the non-execution control routine of the automatic brake control by the PCS control in the embodiment will be described with reference to the flowchart shown in FIG. 6. The control according to the flowchart shown in FIG. 6 is repeatedly executed by the CPU of the collision avoidance support ECU **20** at predetermined time intervals when the ignition switch (not shown) is on. In the following description, the non-execution control of the automatic brake control according to the flowchart shown in FIG. 6 is simply referred to as “non-execution control”. The flags **Fnp**, **Ftnp** and timer count values **Tp**, **Ttp**, and **Ttn** are initialized to 0 at the start of the non-execution control according to the flowchart shown in FIG. 6.

(63) First, in step **S210**, the CPU determines whether or not the flag **Fnp** is 1, that is, whether or not the automatic brake control by the PCS control is already prohibited in a situation where the vehicle **12** is not towing a trailer **102**. When a negative determination is made, the CPU advances the non-execution control to step **S240**, and when an affirmative determination is made, the CPU advances the non-execution control to step **S220**.

(64) In step **S220**, the CPU determines whether or not an absolute value of the steering angle θ detected by the steering angle sensor is equal to or smaller than a reference value **ee** (a positive constant). In this embodiment, the steering angle θ is a turning index value of the vehicle **12**, and the larger the absolute value of the steering angle θ , the higher a degree of turning of the vehicle. When a negative determination is made, the CPU temporarily terminates the non-execution control, and when an affirmative determination is made, in step **S230** the CPU resets the flag **Fnp** to 0 and resets the timer count value **Tp** to 0.

(65) In step **S240**, the CPU determines whether the flag **Ftnp** is 1, that is, whether the automatic

brake control by the PCS control is already prohibited in the situation where the vehicle **12** is towing a trailer **102**. When an affirmative determination is made, the CPU advances the non-execution control to step **S360**, and when a negative determination is made, the CPU advances the non-execution control to step **S250**.

(66) In step **S250**, the CPU determines whether or not the vehicle **12** is towing the trailer based on a detection result of the traction sensor **92**. When an affirmative determination is made, the CPU advances the non-execution control to step **S310**, and when a negative determination is made, the CPU advances the non-execution control to step **S260**.

(67) In step **S260**, the CPU determines whether or not an absolute value of the steering angle θ is equal to or larger than a reference value θ_c (a positive constant larger than θ_e) which is a first reference value. When a negative determination is made, the CPU resets the timer count value T_p to 0 in step **S270**, then temporarily terminates the non-execution control, and when an affirmative determination is made, the CPU advances the non-execution control to step **S280**.

(68) In step **S280**, the CPU updates the timer count value T_p to $T_{pf} + \Delta T$, with T_{pf} as a previous value of the timer count value T_p and ΔT as a cycle time of the flowchart shown in FIG. **6**.

(69) In step **S290**, the CPU determines whether or not the timer count value T_p equal to or larger than a reference value T_{pc} (a positive constant of about 0.5 seconds). When a negative determination is made, the CPU temporarily terminates the non-execution control, and when an affirmative determination is made, in step **S300** the CPU sets the flag F_{np} to 1.

(70) In step **S310**, the CPU determines whether or not an absolute value of the steering angle θ is equal to or larger than a reference value θ_{tc} (a positive constant smaller than θ_c) which is a second reference value. When a negative determination is made, the CPU resets the timer count value T_p to 0 in step **S320**, then temporarily terminates the non-execution control, and when an affirmative determination is made, the CPU advances the non-execution control to step **S330**.

(71) In step **S330**, the CPU updates the timer count value T_p to $T_{tpf} + \Delta T$, with T_{tpf} as a previous value of the timer count value T_p .

(72) In step **S340**, the CPU determines whether or not the timer count value T_p is equal to or larger than a reference value T_{tpc} (a positive constant of about 0.5 seconds). When a negative determination is made, the CPU temporarily terminates the non-execution control, and when an affirmative determination is made, in step **S350** the CPU sets the flag F_{tnp} to 1.

(73) In step **S360**, the CPU determines whether or not an absolute value of the steering angle θ is equal to or smaller than a reference value θ_{te} (a positive constant smaller than θ_e and θ_{tc}) which is a third reference value. When a negative determination is made, the CPU temporarily terminates the non-execution control, and when an affirmative determination is made, the CPU advances the non-execution control to step **S370**.

(74) In step **S370**, the CPU updates the timer count value T_{tn} to $T_{tnf} + \Delta T$, with T_{tnf} as a previous value of the timer count value T_{tn} .

(75) In step **S380**, the CPU determines whether or not the timer count value T_{tn} is equal to or larger than a reference value T_{tnc} (a positive constant of about 3 seconds). When a negative determination is made, the CPU temporarily terminates the non-execution control, and when an affirmative determination is made, in step **S390** the CPU resets the flag F_{tnp} to 0 and resets the timer count values T_p and T_{tn} to 0.

First Modification

(76) FIG. **7** is a flowchart showing a non-execution control routine of the automatic brake control by the PCS control in the first modification. In FIG. **7**, the same steps as the steps shown in FIG. **6** are assigned the same step numbers as the step numbers assigned in FIG. **6**. This also applies to FIGS. **8** and **9** described later.

(77) In the first modification, step **S360A** is executed instead of step **S360** in the embodiment. Other points of this modification are the same as those of the embodiment.

(78) In step **S360A**, the CPU determines whether or not an absolute value of a steering angle θ is

equal to or smaller than the reference value θ_{te} and an absolute value of a time derivative value (steering angular velocity) θ_d of the steering angle θ is equal to or smaller than a reference value θ_{dte} (a positive constant). When a negative determination is made, the CPU temporarily terminates the non-execution control, and when an affirmative determination is made, the CPU advances the non-execution control to step **S370**.

(79) Therefore, in the first modification, when the predetermined time T_{tnc} has elapsed from a time point when the condition that an absolute value of the steering angle θ is equal to or smaller than the reference value θ_{te} and an absolute value of the time derivative θ_d of the steering angle θ is equal to or smaller than the reference value θ_{dte} is satisfied, the flag F_{tnp} is reset to 0, and the prohibition of the automatic brake control is released.

Second Modification

(80) FIG. **8** is a flowchart showing a non-execution control routine of the automatic brake control by the PCS control in the second modification.

(81) In the second modification, the turning index value of the vehicle **12** is a yaw rate Y_r of the vehicle. Therefore, in step **S220B**, the CPU determines whether or not an absolute value of the yaw rate Y_r of the vehicle detected by the yaw rate sensor is equal to or smaller than a reference value Y_{re} (a positive constant). In step **S260B**, the CPU determines whether or not an absolute value of the yaw rate Y_r of the vehicle is equal to or larger than a reference value Y_{rc} (a positive constant larger than Y_{re}) which is a first reference value.

(82) In step **S310B**, the CPU determines whether or not an absolute value of the yaw rate Y_r of the vehicle is equal to or larger than a reference value Y_{rtc} (a positive constant smaller than Y_{rc}) which is a second reference value. In step **S360B**, the CPU determines whether or not an absolute value of the yaw rate Y_r of the vehicle is equal to or smaller than a reference value Y_{rte} (a positive constant smaller than Y_{re} and Y_{rtc}) which is a third reference value.

Third Modification

(83) FIG. **9** is a flowchart showing a non-execution control routine of the automatic brake control by the PCS control in the third modification.

(84) In the third modification, the turning index value of the vehicle **12** is a product $Y_r \cdot \text{Math.V}$ of a yaw rate Y_r of the vehicle and a vehicle speed V , that is, an estimated lateral acceleration G_{yh} of the vehicle. Therefore, in step **S220C**, the CPU determines whether or not an absolute value of the estimated lateral acceleration G_{yh} of the vehicle is equal to or smaller than a reference value G_{yhe} (a positive constant). In step **S260C**, the CPU determines whether or not an absolute value of the estimated lateral acceleration G_{yh} of the vehicle is equal to or larger than a reference value G_{yhc} (a positive constant larger than G_{yhe}) which is a first reference value.

(85) In step **S310C**, the CPU determines whether or not an absolute value of the estimated lateral acceleration G_{yh} of the vehicle is equal to or larger than a reference value G_{yhrc} (a positive constant smaller than G_{yhc}) which is a second reference value. In step **S360C**, the CPU determines whether or not an absolute value of the estimated lateral acceleration G_{yh} of the vehicle is equal to or smaller than a reference value G_{yhte} (a positive constant smaller than G_{yhe} and G_{yhrc}) which is a third reference value.

(86) As can be seen from the above descriptions, according to the embodiment and the first to third modifications, when an obstacle is detected in front of the vehicle **12** by the obstacle detection device **60** (step **S10**), warning is executed as necessary by the PCS control. That is, when a collision prediction time TTC is calculated (step **S20**) and the collision prediction time TTC is equal to or smaller than the warning threshold TTC_w (step **S40**), the warning device **94** is activated to generate an alarm to the effect that the vehicle may collide with the obstacle (step **S50**). Since the warning is also issued when the vehicle **12** is towing a trailer, it is possible to call attention that the vehicle may collide with an obstacle, and a driver can perform collision avoidance steering as necessary.

(87) As described above, when the flags F_{np} and F_{tnp} are 0 (steps **S60** and **S65**), the automatic

brake control by the PCS control (steps S70 to S100) is executed as needed. That is, when the collision prediction time TTC is equal to or smaller than the operating threshold value TTCa (step S70), the required deceleration Gpcs for avoiding the vehicle 12 from colliding with an obstacle is calculated (step S90), and the automatic brake control is executed so that the deceleration of the vehicle 12 becomes the PCS required deceleration Gpcs (step S100). Therefore, even when the vehicle 12 is towing a trailer, it is possible to prevent the vehicle from colliding with an obstacle by the automatic brake control.

(88) Further, when the flag Ftnp is 1 (step S65), the automatic brake control by the PCS control (steps S70 to S100) is not executed. Therefore, when the vehicle 12 is towing a trailer and there is a possibility that a jackknifing phenomenon may occur, the automatic brake control is not executed, so that it is possible to prevent the jackknifing phenomenon from occurring due to the automatic brake control.

(89) Further, according to the embodiment and the first to third modifications, in a situation where the vehicle 12 is not towing a trailer, when it is determined that the turning index value of the vehicle is equal to or larger than the first reference value, the automatic brake control is prohibited. On the other hand, in the situation where the vehicle is towing a trailer, when it is determined that the turning index value of the vehicle is equal to or larger than the second reference value, the automatic brake control is prohibited. The second reference value is smaller than the first reference value.

(90) Therefore, when the vehicle is towing a trailer, the automatic brake control is prohibited from a stage where the turning index value of the vehicle is small as compared to where the vehicle is not towing a trailer. Accordingly, when the vehicle is turning, it is possible to avoid a jackknifing phenomenon caused by the deceleration of the vehicle due to the automatic brake control from a stage where the turning index value of the vehicle is small.

(91) Further, according to the embodiment and the second and third modifications, the prohibition of the automatic brake control is continued until a predetermined time elapses from a time point when it is determined that the turning index value becomes equal to or smaller than a third reference value smaller than the second reference value from a value larger than the third reference value, and the prohibition of the automatic brake control is released after the predetermined time has elapsed from the above time point. Therefore, in a situation where the vehicle has finished turning but the trader is in a turning state, it is possible to prevent the jackknifing phenomenon from occurring due to the automatic brake control.

(92) In particular, according to the first modification, the prohibition of the automatic brake control is released when the predetermined time Ttnc has elapsed from a time point where the condition that an absolute value of the steering angle θ is equal to or smaller than the reference value θ_{te} and an absolute value of the time derivative value (steering angular velocity) θ_d of the steering angle θ is equal to or smaller than the reference value θ_{dte} is satisfied. The absolute value of the time derivative θ_d of the steering angle θ generally becomes equal to or smaller than the reference value θ_{dte} after the absolute value of the steering angle θ becomes equal to or smaller than the reference value θ_{te} . Therefore, according to the first modification, the prohibition of the automatic brake control is continued for a longer time as compared to the embodiment, and it is possible to reduce the possibility that the prohibition of the automatic brake control is released before a trailer goes straight.

(93) Further, according to the first modification, not only when the turning of the vehicle 12 is completed but also when the vehicle 12 changes lanes and an absolute value of the steering angle θ becomes equal to or smaller than the reference value θ_{te} during the lane change, the prohibition of the automatic brake control can be continued. Therefore, when the vehicle 12 changes lanes, it is possible to reduce the possibility that a jackknifing phenomenon occurs due to the automatic brake control.

(94) Further, according to the embodiment and the first modification, since the turning index value

is a steering angle θ , it is possible to control the prohibition of the automatic brake control based on the steering angle detected as a steering operation amount of a driver.

(95) Further, according to the second modification, it is possible to control the prohibition of the automatic brake control based on a yaw rate Y_r of the vehicle detected as one of the turning state quantities of the vehicle.

(96) Further, according to the third modification, it is possible to control the prohibition of the automatic brake control based on a product $Y_r \cdot V$ of a vehicle speed V and a yaw rate Y_r of the vehicle detected as one of the turning state quantities of the vehicle, that is, an estimated lateral acceleration G_{yh} of the vehicle.

(97) Although the present disclosure has been described in detail with reference to the specific embodiment and the first to third modifications, it will be apparent to those skilled in the art that the present disclosure is not limited to the above-described embodiment and the first to third modifications, and various other embodiments are possible within the scope of the present disclosure.

(98) For example, in the above-described embodiment and the first to third modifications, the reference value T_{nc} used for the determination in step **S380** is a positive constant. However, a time for a trailer to continue a turning state even after the vehicle finishes turning is shorter as a vehicle speed V is higher. Therefore, in embodiments the predetermined time during which the prohibition of the automatic brake control is continued from a time point when it is determined that the turning index value becomes smaller than the third reference value from the third reference value smaller than the second reference value is variably set according to a vehicle speed so that the higher the vehicle speed, the shorter the predetermined time. Accordingly, as shown in FIG. **10**, the reference value T_{nc} may variably be set according to a vehicle speed V so that the higher the vehicle speed, the smaller the reference value.

(99) According to this aspect, the predetermined time T_{nc} is variably set according to the vehicle speed so that the higher the vehicle speed V , the shorter the predetermined time. Therefore, while preventing the automatic brake control from being restarted in spite the trailer is still in the turning state when the vehicle speed is low, it is possible to prevent the prohibition of the automatic brake control from being continued unnecessarily for a long time when the vehicle speed is high.

(100) Further, in the above-described embodiment and the first to third modifications, the vehicle **12** has a traction sensor **92**, and in step **S210**, it is determined whether or not the vehicle **12** is towing a trailer based on the detection result of the traction sensor **92**. However, whether or not the vehicle is towing a trailer may be determined based on the information behind the vehicle taken by a back camera. Alternatively, a weight of the vehicle may be estimated based on a relationship between a braking force of the vehicle and a deceleration, and it may be determined whether or not the estimated weight is larger than a weight of the vehicle alone. Further, these determinations may be combined.

(101) Further, in the above-described embodiment and the first to third modifications, the trailer **102** includes the brake ECU **104**, the brake actuator **108**, and the friction brake mechanism **112**. However, the collision avoidance support device and the collision avoidance support program of the present disclosure may be applied to a vehicle towing a trailer that is not provided with a brake ECU and the like.

(102) Further, in the above-described embodiment and the first to third modifications, the stop holding control is performed in the collision avoidance support control. However, when an affirmative determination is made in step **S110**, steps **S120** and **S150** may be executed without executing steps **S130**, **S140** and **S160**.

Claims

1. A collision avoidance support device for a vehicle that includes an obstacle detection device that detects an obstacle in front of a vehicle and an electronic control unit configured to perform automatic brake control to apply braking force automatically to the vehicle when it is determined that an obstacle is detected by the obstacle detection device and the vehicle may collide with the obstacle, wherein the electronic control unit is configured to prohibit the automatic brake control when it is determined that the vehicle is not towing a trailer and a turning index value indicating a degree of turning of the vehicle is equal to or higher than a first reference value, and prohibit the automatic brake control when it is determined that the vehicle is towing a trailer and the turning index value is equal to or larger than a second reference value smaller than the first reference value, and wherein the electronic control unit is configured to continue the prohibition of the automatic brake control until a predetermined time elapses from a time point when it is determined that the turning index value becomes equal to or smaller than a third reference value smaller than the second reference value from a value larger than the third reference value, and release the prohibition of the automatic brake control after the predetermined time has elapsed from the above time point.
2. The collision avoidance support device for a vehicle according to claim 1, wherein the electronic control unit is configured to variably set the predetermined time according to a vehicle speed so that the higher the vehicle speed, the shorter the predetermined time.
3. The collision avoidance support device for a vehicle according to claim 1, wherein the turning index value is a steering angle.
4. The collision avoidance support device for a vehicle according to claim 1, wherein the turning index value is a yaw rate of the vehicle.
5. The collision avoidance support device for a vehicle according to claim 1, wherein the turning index value is a product of a yaw rate of the vehicle and a vehicle speed.
6. The collision avoidance support device for a vehicle according to claim 1, wherein the turning index value is a steering angle, and the electronic control unit is configured to continue the prohibition of the automatic brake control until a predetermined time elapses from a time point when it is determined that a condition that an absolute value of a steering angle is smaller than or equal to the third reference value smaller than the second reference value and an absolute value of a time derivative of the steering angle is smaller than or equal to a reference value of the time derivative is satisfied, and release the prohibition of the automatic brake control after the predetermined time has elapsed from the above time point.
7. A non-transitory computer readable storage medium storing a collision avoidance support program for a vehicle that causes an electronic control unit mounted on a vehicle to execute a step of detecting an obstacle in front of the vehicle by an obstacle detection device and a step of performing automatic brake control that automatically applies braking force to the vehicle when it is determined that an obstacle is detected by the obstacle detection device and the vehicle may collide with the obstacle, wherein the collision avoidance support program includes a step of determining whether the vehicle is towing a trailer, a step of prohibiting the automatic brake control when it is determined that the vehicle is not towing a trailer and a turning index value indicating a degree of turning of the vehicle is equal to or larger than a first reference value, and a step of prohibiting the automatic brake control when it is determined that the vehicle is towing a trailer and the turning index value is equal to or larger than a second reference value smaller than the first reference value, and wherein the collision avoidance support program includes a step of continuing the prohibition of the automatic brake control until a predetermined time elapses from a time point when it is determined that the turning index value becomes equal to or smaller than a third reference value smaller than the second reference value from a value larger than the third reference value, and a step of releasing the prohibition of the automatic brake control after the predetermined time has elapsed from the above time point.

