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(54) DEVICE FOR BRAKE WEAR ASSESSMENT

EINRICHTUNG ZUR BEWERTUNG DER BREMSENABNUTZUNG

DISPOSITIF POUR ÉVALUATION D'USURE DE FREINS

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Description

Field of the Invention

[0001] The present invention relates to systems for assessment of brake wear for vehicles, and in particular to a device for determining the ability of the driver of a vehicle to choose brake system according to the preamble of claim 1.

Background of the Invention

[0002] When driving heavy vehicles, such as trucks, buses and the like, the vehicle economy has in time gained a greater effect on the profitability in the business in which the vehicle is used. Except for the acquiring cost of the vehicle, the largest items of expenditure for a vehicle consist of fuel costs and service costs. These costs are often connected, i.e. a vehicle that is heavily used both consumes more fuel and are exposed to greater wear with increasing service costs as a consequence. An existing problem for the companies that uses heavy vehicles in their business is nonetheless that it is difficult to establish how great part of the fuel consumption and wear that for example is derived from incautious driving, and how great amount that is derived from unfavorable traffic surroundings, such as extremely undulated ground and/or urban environment with heavy traffic. A substantial part of the wear a vehicle is exposed to during incautious driving consists of wear of the brake systems of the vehicle. A heavy vehicle often comprises a number of different brake systems, such as service (foot) brake, motor brake, exhaust brake, retarder and other types of supplementary brake systems.

[0003] From a wear point of view, braking actions with supplementary brakes are preferred since these usually are less stressing for the vehicle. For an unloaded vehicle, it is usually less crucial which brake system that is used, but if, for example, a heavily loaded vehicle is driven in a very long downhill slope, such as in a mountain area, and only the service brake is used, this can result in disastrous consequences where the vehicle even can catch fire because of overheated brake discs and/or brake drums and/or brake linings.

[0004] In the patent application US2005/0131597 is disclosed a system for behavioral analysis of a driver of a vehicle where the system creates sequences of extreme points in (lateral and longitudinal) acceleration, rescales and maps these points against predefined sequences in order to assess the maneuver the driver is performing. An assessment of the driver's aggressiveness and skillfulness is made from how well the sequence corresponds to what is defined as a safe sequence and a sequence that indicates a skillful driver, respectively. The system, however, does not take into account that a vehicle usually has a number of different brake systems.

[0005] In the International application WO2006/008731 there is described a system and a method for analysing and evaluating the performance and attitude of a motor vehicle driver. The document mentions the importance of analysis of the driver's behaviour in specific driving situations, such as passing, lane changing, traffic blending, making turns, handling intersections, handling off- and on-ramps, driving in heavy stop-and-go traffic. Furthermore, it is mentioned that one of the key benefits of monitoring driving behaviour is the ability to determine a driver's consistency, because this is an important indicator of that driver's consistency, and therefore of the safety of that driver's performance. If the driver begins to deviate from an established driving profile, this can be a valuable advance warning of an unsafe condition, i.e. the disclosure in WO2006/008731 is directed to a system for avoiding unsafe driving and not a system for assessment of brake wear for vehicles, and in particular to a device for determining the ability of the driver of a vehicle to choose brake system. FR2859687 discloses a retardation device for motor vehicles. The device comprises a primary retarder, a secondary retarder and a control unit which activates either one of said retarders. Furthermore, the control unit comprises means such as sensors and a processing unit which are used to activate either one of the retarders on the basis of input parameters relating to a driving speed of a vehicle. There Is no device for determining the ability of the driver of a vehicle to choose brake system described.

[0006] The closest prior art according to document US 6,449,551 discloses an electrically controlled braking system for a vehicle having a service brake and parking brake. The system Is configured to separately transmit service brake control signals and parking brake control signals which are generated in one central control module on the basis of corresponding actuating signals via the communication system to the respective control modules actuating the wheel brakes.

[0007] Accordingly, there exists a need to be able to assess the ability of the driver to, in a correct manner, handle the brake systems of the vehicle.

[0008] Summary of the Invention It is an object of the present invention to provide a device for determining the ability of the driver of a vehicle to choose brake system which solves the above problem. This and other objects are obtained according to the present Invention by a device as defined in claim 1. According to the present invention, It is provided a device for determining the ability of the driver of a vehicle to choose brake system, wherein said vehicle comprises at least a first and a second brake system, and wherein said driver, during a braking action, freely can choose which system or systems of said plurality of brake systems to use. The device comprises means for, at a braking action, for each brake

system receive at least one parameter value representing the usage of the said brake system during said braking action. Further, the device comprises means for receiving a parameter representing the total usage of the said plurality of brake systems during said braking action, and means for, at least for the said first brake system, comparing the usage of the brake system with the vehicle's total brake system usage during the braking action to assess the driver's ability to use said brake system. The said parameter representing said total usage of the brake systems during the braking action can, for example, consist of energy dissipated during the braking action or the total time of the braking action.

[0009] This has the advantage that every performed braking action can be studied in detail to assess whether it was performed with the correct brake system or combination of brake systems.

[0010] Further, the device according to the invention can comprise means for receiving at least one parameter value representing the vehicle surroundings, whereby said vehicle surroundings can influence the assessment of the ability of the driver to use brake systems. This has the advantage that a very accurate estimation of the ability of the driver to use the vehicle's different brake systems in different situations can be obtained.

[0011] The said parameter value representing the usage of a brake system during said braking action can consist of the time of usage of the brake system during the braking action. This has the advantage that a simple representation of the usage of the brake system during the braking action can be obtained. Alternatively, the energy dissipated by the brake system during said braking action can be used. This has the advantage that a very accurate value of the usage of a specific brake system can be obtained, and thereby a very accurate estimation of the ability of a driver to handle the brake systems of a vehicle.

Brief description of the drawings

[0012]

Fig. 1 schematically illustrates a control system for a vehicle where the present invention advantageously can be utilized.

Fig. 2a-b illustrates an example of a device according to the present invention.

Detailed Description of Example Execution Forms

[0013] In this description, the term vehicle internal sensors means sensors that only obtains data from the relative movements of the vehicle, i.e. changes in movements from one time to another, and which do not use information from external systems, such as positioning systems or map databases. Such vehicle internal sensors can, for example, consist of lateral acceleration sensors, i.e. sensors delivering signals with which the rate of change of the vehicle speed in the lateral direction can be determined, for example in order to determine whether the vehicle runs the risk of tipping over due to the driver performing an incautious maneuver. Furthermore, the sensors can comprise wheel speed sensors, i.e. sensors that delivers signals with which the rotation speed of the wheels and traveled distance can be determined, steering angle sensors that deliver signals with which the angle of the steering wheels in relation to the longitudinal axis of the vehicle can be determined, and sensor means for delivering signals from which the yaw rate, i.e. how quickly the vehicle turns, can be calculated.

[0014] In fig. 1 is schematically illustrated a control system for a vehicle 100 with which the present invention can be utilized. The vehicle 100 comprises a front shaft 101 with steering wheels 102, 103, a rear drive shaft 104 with driving wheels 105-108, and a rear pressure equalizer shaft 109 with wheels 110, 111. Furthermore, the vehicle 100 contains an engine 113 connected to a gear box 112, which drives the drive shaft 104 by means of an output shaft 114 from the gear box.

[0015] Gear box 112 and motor 113 are controlled by control units 115, 116, respectively, which are controlled by a main control unit 117. The Engine Management System (EMS) 116 controls the motor functions of the vehicle, which, for example, can consist of fuel injection and motor-brake. The control is based on a number of input signals, which can consist of signals from (not shown) throttle controls (the position of the accelerator pedal), speed sensor and brake management system. The Gearbox Management System (GMS) 115 controls the gear functions, wherein, when using an automatic gearbox, the gear shifting can be controlled based on an input signal from speed sensors, in manual gear shifting the shifting can be controlled from an input signal from a gear selector (gear shift lever).

[0016] Furthermore, the vehicle contains a Brake Management System (BMS) with a break control unit 120, which controls the brake functions of the vehicle, such as automatic calculation of the load so that a given pedal position always can result in the same brake effect regardless of the load. The brake control unit controls the various brake systems of the vehicle, e.g. retarder and other supplementary brake systems, exhaust brake and service brake on the basis of commands from the driver, and sends control signals to system modules (not shown) dispersed on the chassis, where electrical control signals are used, e.g. to adjust brake pressure.

[0017] A vehicle of the kind shown in fig. 1 includes, except for the above, typically a number of additional control units, see, for example, WO01/86459 A1. Therefore, the above described control units constitute mere examples of what can exist in a vehicle. As is appreciated by a person skilled in the art, two or more of the above described control units can, of course, be integrated in one single control unit.

[0018] In a vehicle of the type shown in fig. 1, it is, as was previously mentioned, very important that the driver during a braking action uses the correct brake system to avoid unnecessary wear, and/or unnecessary risks resulting from overloading a specific brake system. As also was mentioned, it is difficult for an owner of a vehicle to know the manner in which the vehicle is being driven by a leased/employed driver and in which way the driver's driving manner regarding brake usage influences the service costs of the vehicle.

[0019] The present invention provides a device for evaluating the vehicle driver's usage of the vehicle's different brake systems.

[0020] The invention will be explained more in detail with reference to fig. 2a-b, where the vehicle of fig. 1 is shown in fig. 2a as provided with a device 200 according to the invention.

[0021] The device 200 is shown more in detail in fig. 2b and comprises means 210 for receiving brake system related signals and other vehicle related signals. In the disclosed exemplary embodiment, the vehicle comprises four different kinds of brake systems, retarder, exhaust brake, service (foot) brake and motor-brake, and the device 200 comprises means for receiving signals concerning these brake systems. For example, the position of a brake control set by the driver for a certain brake system can by means of the construction of the vehicle be arranged to be translated to an electric signal, which then is processed by the control system of the vehicle, for example the brake control unit 120, or a separate control unit for the concerned brake system, to be able to apply a corresponding brake torque, i.e. how large part of the total torque of the concerned brake system that is to be applied. These data can, for various purposes, be communicated between different control units via a vehicle network that is interconnected by one or more data buses by means of which data can be communicated between the control units. Data can, for example, be transmitted on any of the data bus formats CAN (Controller Area Network), TTCAN or FlexRay. Correspondingly, other vehicle related signals can be made accessible on the data bus via an appropriate control unit. Accordingly, existing vehicles often already comprise functionality for making information requested by the invention accessible on a vehicle data bus. The means 210 of the device 200 can therfore constitute a data bus connection for reception of signals representing brake control positions or other brake system related data. This information can be made available on the data bus jointly for the brake systems by the brake system control unit 120, or from each respective brake system/brake control unit (not shown) separately. The received signals are then provided to a data processing unit 211, the function of which is being described below.

[0022] The data processing unit 211 can, for example, consist of a processor, which is controlled by means of operation instructions, such as a computer program generated by means of an appropriate programming language, and being stored in a storage means, said storage means being built-in or connected to the processor. The said storage means can, for example, consist of one or more from the group: ROM (Read-Only Memory), PROM (Programmable Read-Only Memory), EPROM (Erasable PROM), Flash-memory, EEPROM (Electrically Erasable PROM). The device 200 can consist of a data processing unit with both integrated memory and integrated bus interface for a data bus of the above type and therefore be constructed in very compact manner. The device 200 further comprises output means 212 for output of processed data, e.g. to continuously transmit data to a fleet management central or for presentation to the vehicle driver, e.g. by means of a display arranged in the driver's cabin. Instead of making the information available on a data bus according to the above, the said means 210 can, instead, consist of connection points for direct reception of sensor signals representing brake pedal/brake control positions or, in the simplest case, signals representing if a certain brake system is activated or not. The device can, therefore, comprise means such as A/D-converters or receivers for receiving wirelessly transmitted sensor signals to convert received signals to a common format, which is adapted to said data processing unit 211, which then performs appropriate calculations.

[0023] In a first embodiment, the brake system specific signals consist of the time during a braking action that each brake system has been activated. This can for example be accomplished by the device 200 receiving signals from, e.g., the brake control unit 120 regarding the respective brake system for as long as the brake system is active. Alternatively, the device can, when the braking action is finished, receive values that represents the time that the brake system has been active.

[0024] With this information, the choice of brake system can be directly evaluated in the vehicle.

[0025] The obtained information can, in the case of time indications, be used by the data processing unit 211 to calculate a brake assessment value U:

$$U = K\frac{\left(T_{Retarder} + T_{Exhaustbrake} + T_{Motor_torque}\right)}{T_{Deceleration}}, \quad 0 < U < 1 \qquad (1)$$

where the higher the value of *U* means the better usage of the brake systems during a braking action. As is realized, the value will, to a great extent, be influenced by the service brake, which is not included in the equation. If only the service brake is used, *U*=0 is obtained, which consequently is a very poor value. It should, however, be mentioned that there is an occasion where service brake usage can be motivated, and that is when using unloaded vehicles. Since vehicles having a low weight wear brakes to a much smaller extent than heavily loaded vehicles, a threshold value of the vehicle mass can therefore be used to activate analysis of the braking actions. Consequently, the device 200 advantageously also comprises means for receiving a calculated vehicle mass or parameter value(s) by means of which the vehicle mass can be calculated. The parameter values that are required for calculation of the vehicle mass are usually also accessible on the data bus of the vehicle and can thereby e.g. be provided to the data processing unit 211 by means of the said receiving means 210.

[0026] *K* is a constant which is set to a suitable value. For example, *K* can be controlled by the extent of the usage of the service brake that is regarded to be motivated. *K* can be set for each braking action, and, for example, depend on the vehicle mass and/or driving resistance. With knowledge about the speed of the vehicle, the propelling torque of the motor, the configuration of the vehicle and other surroundings data, the mass of the vehicle, as well as the current driving resistance, can be calculated. The driving resistance is a total representation of the resultant of the head wind, the rolling resistance and the gravity that accelerates/decelerates the car, and can therefore be used as a representation of the inclination of the road. Accordingly, *K* can be made dependant of the inclination of the road, and also of how the inclination of the road has changed historically (e.g., a plurality of consecutive downhill slopes). *T* represents the time of usage of every brake system and $T_{braking\ action}$ is the time of the entire braking action.

[0027] To calculate $T_{braking\ action}$, the device can comprise means for receiving the speed of the vehicle, or parameter values from which the speed of the vehicle can be calculated, in order to, by means of this data, determine for how long a retardation is in progress and hence $T_{braking\ action}$. These data are usually also accessible by means of some control unit on the data bus of the vehicle, and can thereby in a simple manner be provided to the data processing unit 211. Another common procedure is that the requested total retardation is reported on the vehicle network, and is thus accessible in that manner.

[0028] In this way, a *U* value is calculated for each braking action, whereby it can be established that if *U* exceeds a certain threshold value, the braking action is assessed to be a good braking action. Alternatively, the *U* value can represent a percentage of the, in theory, "perfect" 100 % braking action.

[0029] By summing up the *U* values of all braking actions during a vehicle's journey, and dividing with the number of braking actions, a measurement of the efficiency of the manner in which the driver uses the vehicle's different brake systems can be obtained in a simple manner.

[0030] In an alternative embodiment, the device, instead, receives signals representing the applied brake torque for the brake systems, respectively, i.e. brake torque from service brake (disc or drum brake), brake torque from retarder brake, brake torque from exhaust brake and brake torque from one or a plurality of other supplementary brakes, such as motor-brake torque. Instead of using a time indication according to the above, it is possible to, instead of *T* based on said brake torque, use an energy measurement *E,* whereby the above equation is transformed to

$$U = K\frac{\left(E_{Retarder} + E_{Exhaust_break} + E_{Supplementary_brake}\right)}{E_{deceleration}} \qquad (2)$$

where *E* represents the amount of energy that is used during a braking action for each respective brake system and for the entire braking action. This measurement is more accurate since it specifies the portion of the total brake energy that is dissipated by a particular brake system. If, for example, the service brake is used for a short period of time, but with high load, this embodiment provides a more accurate value of the impact of the service brake.

[0031] The manner in which the above-mentioned brake energy values can be obtained will now be described more in detail. As was mentioned above, there is a large quantity of information accessible on vehicle internal networks in current vehicles. From this information, it is possible, by combining various simple laws of physics, to in a qualified manner obtain information about absorbed brake energy from the different brake systems.

[0032] The engine reports, via the control unit 116, its torque to the control system of the vehicle, i.e. it is made accessible on a data bus. The torque can be positive when fuel is consumed or negative when the driver is motor-braking. Likewise, the exhaust brake reports the torque that it brakes the engine with, either to the brake control unit 120, which in that case makes these data accessible on a data bus or directly onto a data bus by means of a separate control unit. Generally, this brake torque is zero, but when the driver or brake systems request exhaust braking, the current brake torque is shown. Likewise, the retarder reports its brake moment correspondingly. Disc brake systems and drum brake systems can either report brake pressure to a brake control unit or directly onto a data bus by means of a separate control unit. Consequently, it is possible to provide the desired information to the data processing unit 211

in a simple manner to perform the calculation below.

[0033] As is well known, energy can be expressed as force * distance, which is the same as time integrating force and speed. Since information about the speed of the vehicle is accessible via the traffic on the vehicle network, a conversion of the obtained brake torques to the actual forces acting on the wheels of the vehicle remains.

[0034] Regarding motor brake torque and exhaust brake torque, these are first multiplied with the current gear box ratio (this information is usually also accessible on the networks) and then with the rear axle ratio to finally be divided with the radius of the drive wheels. These factors are normally well known from the specification of the vehicle, but can also be available on the internal vehicle networks. However, if the driver has put the gear in neutral, if the vehicle is shifting gears or if the clutch is depressed, these two braking torques must be zero since the motor is not connected to the drive wheels.

[0035] The braking force of the retarder is dependent on the position of the retarder. Normally, the retarder is arranged after the gear box, in which case the torque should be multiplied with rear axle ratio and divided with the radius of the drive wheels.

[0036] The torque of the disc and drum brakes, on the other hand, only has to be divided with the radius of the drive wheels. If information about these brake torques are not available, a model can be used to translate from brake pressure to brake torque. Here, information about brake type, the number of braking shafts etc. is used. All such information is known from the vehicle specification and/or is accessible on the internal networks.

[0037] Another alternative method of calculating the brake power for disc and drum brakes, which can be used when the requested retardation is known, is, with information about the vehicle mass (which often is available from the network traffic), to calculate the contribution to the retardation from motor-brake, exhaust brake and retarder ($F = m*a \rightarrow a = F/m$). Then it is known that the disc or drum brakes contributes with remaining retardation, i.e. the remaining difference to the requested retardation. Accordingly, the brake power from disc or drum brakes can be determined in this manner as well.

[0038] Consequently, we can calculate the brake power for each brake system in every given situation. By integrating these forces over the distance of the entire braking action, the total energy that is absorbed by each brake system can be determined in order to be used according to the invention as above.

[0039] The inventive method can, however, be further refined by taking additional parameters into consideration, such as brake lining temperature and/or brake lining wear. During a braking action in a long downhill slope a significant rise of temperature can occur if the braking action is not performed in a careful manner. In eq. (3) is shown how the brake lining temperature and brake lining wear can influence the U value.

$$U = K\frac{\left(E_{Retarder} + E_{Exhaustbrake} + E_{Supplementarbrake}\right)}{E_{deceleration}} * S_{temp} * S_{lining},$$

wherein $S_{temp} > 1, S_{lining} > 1$

[0040] S_{temp} is a factor for brake lining temperature and S_{lining} is a factor for brake lining wear. For example, these can be determined as $S_{temp} = C_1$*brake temp, $S_{lining}=C_2$* (1-remaining lining). In this way, an undesired usage of the service brake, resulting in high temperatures, will have a even greater impact on the brake usage assessment.

[0041] As is realized, K is set to a suitable value.

[0042] So far, the invention has been described with a system that is applicable for all braking actions regardless of the surroundings. The brake usage assessment according to the invention, however, can be further improved. For example, the device 200 can include means for receiving the lateral acceleration of the vehicle, to, during the braking action, be able to determine if the brake system that is used in a heavy braking action in, e.g. a curve is a suitable choice. For example, it is inappropriate to use retarder braking in such braking actions, because it increases the risks of skidding in this case, and it is more difficult to control a skid in these situations.

[0043] To take advantage of the full potential of the invention, a U-value can be produced for each brake system. This can be performed by dividing eq. (2) above, and, in addition, introduce a U value for the service brake, where brake lining temperature and brake lining wear influences the service brake value by a function $f(s)$. This results in:

$$U_1 = K\frac{E_{Retarder}}{E_{deceleration}}, \quad U_2 = K\frac{E_{Exhaust_brake}}{E_{deceleration}}, \quad U_3 = K\frac{E_{Supplementary_brake}}{E_{deceleration}},$$

$$U_4 = K\frac{E_{Service_brake}}{E_{deceleration}} * f(s)$$

, where it is desired that $U_1 + U_2 + U_3 > U_4$.

[0044] In this way, the driver's usage of each specific brake system can be evaluated.

[0045] Apart from evaluating the brake system usage according to the above, the surroundings of the vehicle can also be used in the assessment. In the parallel Swedish Patent Application 0601176-1 entitled "Klassificeringsanordning (in English: Classification Device)" and having the same filing date as the present application, is described a solution for, during traveling, determining the type of a distance, which is divided into segments, of a way that a vehicle is traveling. The described solution can, in a very accurate manner, determine the type of a plurality of consecutive or adjacent segments, such as right-hand turn, left-hand turn, straight stretch, uphill slope, downhill slope, and, in particular together with time and/or speed data perform an accurate classification of the distance. The classification can, for example, consist of idle driving, power take off (PTO), marshalling, queue, city centre, urban area, undulated and/or straight or curved road, straight and level or undulated road. The device 200 according to the present invention, can comprise means for receiving a surroundings classification from a device according to the said Patent Application. Alternatively, the device 200 according to the invention can comprise means for performing the described traffic surroundings classification. By taking the surroundings of the vehicle into account for every braking action, an even better analysis of the driver's brake usage ability can be performed. Since the described solution can give a very accurate description of the momentary surroundings of the vehicle, a very accurate evaluation of each braking action can also be performed.

[0046] In table 1, an example of suitable U values for different traffic surrounding situations is shown. It is assumed that K = 1 and that f(s) = 1 in the table.

#	Situation	U_1	U_2	U_3	U_4
1	Braking action with light vehicle	-	-	-	-
2	Normal braking action, level road	$\sum_{i=1}^{3} U_i \geq 0,7$			≤ 0,3
3	Braking action, short downhill slope	$\sum_{i=1}^{3} U_i \geq 0,6$			≤ 0,4
4	Braking action, long downhill slope	$\sum_{i=1}^{3} U_i \geq 0,9$			≤ 0,1
5	Braking action, urban environment	≥ 0,5	0	-	≤ 0,5
6	Braking action between hours 18-08	-	0	-	-
7	Braking action, heavy lateral acc.	0	0	0	1

[0047] By using this table, a representative U value can be calculated for each braking action and for each braking action be compared with a reference *U* value that is representative for the braking action.

[0048] In situation 5 and 6 in table 1 it is desirable to avoid use of the exhaust brake. This is because of legislation that in many areas criminalizes usage of exhaust brake in urban environment as well as at night. For this reason, drivers should not be encouraged to use this supplementary brake at such occasions.

[0049] Accordingly, the ability of the driver to use the correct brake system can continuously be evaluated during traveling with the vehicle or afterwards. The vehicle can also be provided with a display that continuously shows the driver's ability to the driver, for example as a percentage between 0 and 100, where, for example, a result exceeding 85 % indicates very good brake usage ability.

[0050] The method according to the invention can thus also evaluate whether the driver is using the correct brake system, not only the manner in which the chosen brake system is used. It can be investigated at all braking actions whether the most suitable brake system has been used. By taking surroundings data into account to make different demands on the braking actions, a more accurate assessment can be accomplished.

[0051] With knowledge about the driver's ability to brake with the correct brake system in different situations, the driver can automatically be trained to a better behavior, for example by means of feedback via a display arranged in the vehicle. The result calculated by the data processing unit can then be output via output means 212, for example to a data bus to be provided to the display unit for displaying. Additionally, the information can be used by the driver's superiors to determine which driver that is in need for help to improve his/her driving, or to identify a driver who is doing particularly well and possibly reward him/her. Instead of using the above-mentioned method to classify the surroundings of the vehicle, other methods to assess the traffic surroundings can also be used, e.g., positioning systems and map data and/or an inclinometer.

[0052] The present invention can also be combined with other systems for evaluation of a vehicle driver.

[0053] In the parallel Swedish Patent Application 0601175-3 entitled "Anordning for bestämning av en förutseendeförmåga (in English: Device for determining an anticipation ability)" and having the same filing date as the present invention, it is described a solution to assess a vehicle driver's anticipation ability. The present invention can advantageously be utilized together with the said solution.

[0054] Further, in the parallel Swedish Patent Application 0601174-6, entitled "Anordning for bestämning av ett bränsleförbrukningsbeteende (in English: Device for determining a fuel consumption behavior)" and having the same filing date as the present application, is described a solution together with which the present invention advantageously can be utilized. This patent application discloses a device for evaluating a vehicle driver's ability to drive fuel efficient by studying the driver's consumption in special cases such as tops of hills, valleys and downhill slopes.

[0055] By combining a plurality of different procedures for evaluating a vehicle driver, a very accurate determination of the vehicle driver can, when put together, be performed.

[0056] As is realized, the vehicle can be arranged to continuously transmit data to a monitoring central, whereby the above evaluation can be performed in the monitoring central, instead of in the vehicle.

Claims

1. Device (200) for determining the ability of a vehicle driver to choose a brake system when driving said vehicle (100), wherein said vehicle (100) comprises at least a first and a second brake system, and wherein the said driver during a braking action can influence the choice of the said brake system, wherein the device comprises:

   - means (210) for, at a braking action, each brake system receive at least one parameter value representing the usage of the said brake system during the said braking action,
   characterized in that the device further comprises
   - means (210) for receiving a parameter representing the total use of the said plurality of brake systems during the said braking action, and
   - means (210) for, at least for said first brake system, comparing the usage of the said brake system with the total brake system usage of the vehicle (100) during the braking action for assessing the driver's ability to use the said brake system, wherein said parameter representing the total usage of the said brake systems consists of energy dissipated during the braking action.

2. Device (200) according to claim, wherein it comprises means for performing said comparison for a plurality of the brake systems of the vehicle (100), wherein the total usage of the said plurality of brake systems is compared with the total brake system usage of the vehicle (100) during the braking action to assess the driver's ability to use said brake systems.

3. Device (200) according to any of the claims 1-2, whereby at least one of said brake systems comprises brake linings, wherein brake lining temperature and/or brake lining wear is arranged to influence the assessment at said comparison.

4. Device (200) according to any of the preceding claims, wherein the device further comprises means for receiving at least one parameter value representing the vehicle surroundings, whereby said vehicle surroundings are arranged to influence the assessment at said comparison.

5. Device (200) according to any of the preceding claims, wherein a parameter value representing the usage of a brake system during the said braking action is constituted by the usage time of the said brake system and/or the energy dissipated by the brake system during said braking action.

6. Device (200) according to any of the preceding claims, wherein the device is arranged to, from the said brake system, continuously, with certain intervals or with predetermined intervals obtain parameter values during said braking action.

7. Device (200) according to any of the preceding claims, wherein said device (200) further comprises means for dividing a distance of the way a vehicle (100) is travelling into segments,

   - means for determining that a segment Is started,
   - means for determining a reference direction of movement,

- means for, during said segment, receiving at least one direction parameter value, which constitutes a representation of the direction of movement of the vehicle, or with which a representation of the direction of movement of the vehicle can be determined,
- means for determining if the vehicle has reached the end of the segment,
- means for, from said received direction parameter values, determining the type of the segment, and
- means for, at said assessment of the driver's ability to use the said brake system, take Into consideration the type of one or a plurality of consecutive or adjacent segment (s).

8. Device (200) according to any of the claims 1-7, **characterized in that** said parameter values are arranged to be generated by vehicle internal sensors.

9. Device (200) according to claim 7 or 8, **characterized in that** said segment type is constituted by any from the group: right-hand turn, left-hand turn, right-hand curve, left-hand curve, straight stretch, roundabout, top of a hill, valley, crossing, right-hand turn in crossing, left-hand turn in crossing, level road, uphill slope, downhill slope,

10. Device (200) according to any of the preceding claims, **characterized in that** one or more of said means at least partially consist of a computer program, wherein the device at least partially consists of a computer program product comprising a computer readable medium and a computer program, wherein the computer program is included in the computer readable medium.

11. Device (200) according to claim 10, **characterized in that** said computer readable medium consists of one or more of the group: ROM (Read-Only Memory), PROM (Programmable Readonly Memory), EPROM (Erasable PROM), Flash memory, EEPROM (Electrically Erasable PROM).

12. Vehicle (100), **characterized in that** it comprises a device (200) according to any of the claims 1-11.

Patentansprüche

1. Vorrichtung (200) zum Bestimmen der Fähigkeiten eines Fahrzeugführers zur Auswahl eines Bremssystems beim Führen eines Fahrzeugs (100), wobei das Fahrzeug (100) mindestens ein erstes und ein zweites Bremssystem aufweist und bei dem der Fahrzeugführer die Auswahl der Bremssysteme während eines Bremsvorgangs beeinflussen kann, wobei die Vorrichtung folgendes umfasst:

- Mittel (210), um bei einem Bremsvorgang von jedem Bremssystem einen Parameterwert zu erhalten, der den Gebrauch des entsprechenden Bremssystems während des gesamten Bremsvorgangs darstellt,
dadurch gekennzeichnet, dass die Einrichtung weiterhin folgendes aufweist:
- Mittel (210), um einen Parameter zu erhalten, der die Gesamtnutzung der Mehrzahl von Bremssystemen während des gesamten Bremsvorgangs beschreibt;
- Mittel (210), um für mindestens das erste der Bremssysteme die Nutzung dieses Bremssystems mit der Gesamtnutzung der Bremssysteme des Fahrzeugs (100) während des Bremsvorgangs zu vergleichen, um die Fähigkeit des Fahrers zur Benutzung dieses Bremssystems zu bewerten, wobei der die Gesamtnutzung der Bremssysteme darstellende Parameter aus im Bremsvorgang dissiplerter Energie gebildet wird,

2. Vorrichtung (200) nach Anspruch 1, wobei diese Einheiten aufweist, um den genannten Vergleich für eine Mehrzahl von Bremssystemen des Fahrzeugs (100) auszuführen, wobei die Gesamtnutzung der Mehrzahl von Bremssystemen verglichen wird mit der Gesamtnutzung der Bremssysteme des Fahrzeugs (100) während des Bremsvorgangs, um die Fählgkelt des Fahrzeugführers zur Nutzung der Bremssysteme zu bewerten.

3. Vorrichtung (200) nach einem der Ansprüche 1 bis 2, wobei mindestens eines der Bremssysteme Bremsbeläge aufweist und die Temperatur der Bremsbeläge und/oder der Verschleiß der Bremsbeläge die Bewertung beim genannten Vergleich beeinflusst.

4. Vorrichtung (200) nach einem der vorhergehenden Ansprüche, wobei die Vorrichtung weiterhin Einheiten aufweist, um mindestens einen Parameterwert, welcher die Fahrzeugumgebung darstellt, zu erhalten und diese Fahrzeugumgebung die Bewertung beim genannten Vergleich beeinflusst.

5. Vorrichtung (200) nach einem der vorhergehenden Ansprüche, wobei ein Parameterwert, der die Nutzung eines

Bremssystems während des Bremsvorgangs darstellt, gebildet wird durch die Anwendungszeit des Bremssystems und/oder der vom Bremssystem im Bremsvorgang dissipierten Energie.

6. Vorrichtung (200) nach einem der vorhergehenden Ansprüche, wobei die Einrichtung (200) derart ausgeführt ist, dass vom Bremssystem kontinuierlich In gewissen oder In vorgegebenen Intervallen Parameterwerte während des Bremsvorgangs erhalten werden.

7. Vorrichtung (200) nach einem der vorhergehenden Ansprüche, wobei die Einrichtung weiterhin Mittel umfasst, um eine Strecke, welche das Fahrzeug (100) zurückgelegt, in Segmente zu unterteilen,

- Mittel, um zu bestimmen, dass ein Segment gestartet wurde,
- Mittel, um eine Referenzrichtung der Bewegung zu bestimmen,
- Mittel, um während des Segments wenigstens einen Richtungsparameter zu erhalten, weicher eine Darstellung der Bewegungsrichtung des Fahrzeugs bildet, oder mit dem eine Darstellung der Bewegungsrichtung des Fahrzeugs bestimmt werden kann,
- Mittel zur Bestimmung, ob das Fahrzeug das Ende eines Segments erreicht hat,
- Mittel, um aus den Richtungsparameterwerten die Art des Segments zu bestimmen, und
- Mittel, um bei der Bewertung der Fähigkeit des Fahrzeugführers zur Benutzung des Bremssystems die Art eines oder mehrerer aufeinanderfolgender oder angrenzender Segmente zu berücksichtigen.

8. Vorrichtung (200) nach einem der Ansprüche 1 bis 7,
dadurch gekennzeichnet, dass besagte Parameterwerte mittels fahrzeuginterner Sensorik generiert werden.

9. Vorrichtung (200) nach Anspruch 7 oder 8,
dadurch gekennzeichnet, dass die Segmentart einem der folgenden Elemente entspricht: Rechtsabbiegung, Linksabblegung, Rechtskurve, Linkskurve, gerade Strecke, Kreisverkehr, Hügelspitze, Tal, Kreuzung, Rechtsabblegung auf einer Kreuzung, Linksabblegung auf einer Kreuzung, ebene Fahrbahn, Steigung, Gefälle.

10. Vorrichtung (200) nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet, dass eines oder mehrere der genannten Mittel mindestens teilweise aus einem Computerprogramm bestehen, wobei die Vorrichtung zumindest teilweise aus einem Computerprogrammprodukt besteht, welches ein computerlesbares Medium und ein Computerprogramm umfasst, wobei das Computerprogramm Im computerlesbaren Medium enthalten ist.

11. Vorrichtung (200) gemäß Anspruch 10,
dadurch gekennzeichnet, dass das computerlesbare Medium aus einem oder mehreren Elementen der folgenden Aufzählung besteht: ROM (Read-Only Memory), PROM (Programmable ROM), EPROM (Erasable PROM), Flash memory, EEPROM (Electrically Erasable PROM).

12. Fahrzeug (100),
dadurch gekennzeichnet, dass es eine Vorrichtung (200) aufweist, gemäß einem der Ansprüche 1 bis 11.

Revendications

1. Dispositif (200) pour déterminer l'aptitude d'un conducteur de véhicule à choisir un système de frein lors de la conduite dudit véhicule (100), ledit véhicule (100) comprenant au moins un premier et un deuxième systèmes de frein, et ledit conducteur, durant une action de freinage, pouvant influencer le choix dudit système de frein, le dispositif comprenant :

- des moyens (210) pour que, lors d'une action de freinage, chaque système de frein reçoive au moins une valeur de paramètre représentant l'utilisation dudit système de frein durant ladite action de freinage, **caractérisé en ce que** le dispositif comprend de plus:
- des moyens (210) pour recevoir un paramètre représentant l'utilisation totale de ladite pluralité de systèmes de frein durant ladite action de freinage, et
- des moyens (210) pour, au moins pour ledit premier système de frein, comparer l'utilisation dudit système de frein à l'utilisation de systèmes de frein totale du véhicule (100) durant l'action de freinage pour estimer l'aptitude du conducteur à utiliser ledit système de frein, ledit paramètre représentant l'utilisation totale desdits systèmes

de frein étant constitué par l'énergie dissipée durant l'action de freinage.

2. Dispositif (200) selon la revendication 1, dans lequel il comprend des moyens pour effectuer ladite comparaison pour une pluralité des systèmes de frein du véhicule (100), l'utilisation totale de ladite pluralité de systèmes de frein étant comparée à l'utilisation de systèmes de frein totale du véhicule (100) durant l'action de freinage pour estimer l'aptitude du conducteur à utiliser lesdits systèmes de frein.

3. Dispositif (200) selon l'une quelconque des revendications 1 à 2, grâce auquel au moins l'un desdits systèmes de frein comprend des garnitures de frein, la température des garnitures de frein et/ou l'usure des garnitures de frein étant utilisées de façon à influencer l'estimation lors de ladite comparaison.

4. Dispositif (200) selon l'une quelconque des revendications précédentes, dans lequel le dispositif comprend de plus des moyens pour recevoir au moins une valeur de paramètre représentant l'environnement du véhicule, grâce à quoi ledit environnement du véhicule est agencé de façon à influencer l'estimation lors de ladite comparaison.

5. Dispositif (200) selon l'une quelconque des revendications précédentes, dans lequel une valeur de paramètre représentant l'utilisation d'un système de frein durant ladite action de freinage est constituée par le temps d'utilisation dudit système de frein et/ou l'énergie dissipée par le système de frein durant ladite action de freinage.

6. Dispositif (200) selon l'une quelconque des revendications précédentes, dans lequel le dispositif est configuré, à partir dudit système de frein, de façon continue, avec certains intervalles ou avec des intervalles prédéterminés, de façon à obtenir des valeurs de paramètre durant ladite action de freinage.

7. Dispositif (200) selon l'une quelconque des revendications précédentes, dans lequel ledit dispositif (200) comprend de plus des moyens pour diviser une distance du chemin que parcourt un véhicule (100) en segments,

- des moyens pour déterminer qu'un segment est débuté,
- des moyens pour déterminer une direction de mouvement de référence,
- des moyens pour, durant ledit segment, recevoir au moins une valeur de paramètre de direction, qui constitue une représentation de la direction de mouvement du véhicule, ou avec laquelle une représentation de la direction de mouvement du véhicule peut être déterminée,
- des moyens pour déterminer si le véhicule a atteint la fin du segment,
- des moyens pour, à partir desdites valeurs de paramètre de direction reçues, déterminer le type du segment, et
- des moyens pour, lors de ladite estimation de l'aptitude du conducteur à utiliser ledit système de frein, prendre en considération le type d'un ou d'une pluralité de segment(s) consécutifs ou adjacents.

8. Dispositif (200) selon l'une quelconque des revendications 1 à 7, **caractérisé en ce que** lesdites valeurs de paramètres sont configurées de façon à être générées par des capteurs internes au véhicule.

9. Dispositif (200) selon la revendication 7 ou 8, **caractérisé en ce que** ledit type de segment est constitué par l'un quelconque parmi le groupe : virage à droite, virage à gauche, courbe à droite, courbe à gauche, ligne droite, rond-point, sommet d'une rampe, vallée, croisement, virage à droite dans un croisement, virage à gauche dans un croisement, route plate, rampe montante, pente descendante.

10. Dispositif (200) selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**un ou plusieurs desdits moyens sont au moins partiellement constitués par un programme Informatique, le dispositif étant au moins partiellement constitué par un produit de programme informatique comprenant un support lisible par un ordinateur et un programme informatique, le programme informatique étant inclus dans le support lisible par un ordinateur.

11. Dispositif (200) selon la revendication 10, **caractérisé en ce que** ledit support lisible par un ordinateur est constitué par l'une ou plusieurs du groupe : ROM (mémoire morte), PROM (mémoire morte programmable), EPROM (mémoire morte programmable effaçable), mémoire flash, EEPROM (mémoire morte programmable effaçable électriquement).

12. Véhicule (100), **caractérisé en ce qu'**il comprend un dispositif (200) selon l'une quelconque des revendications 1 à 11,

Fig. 1

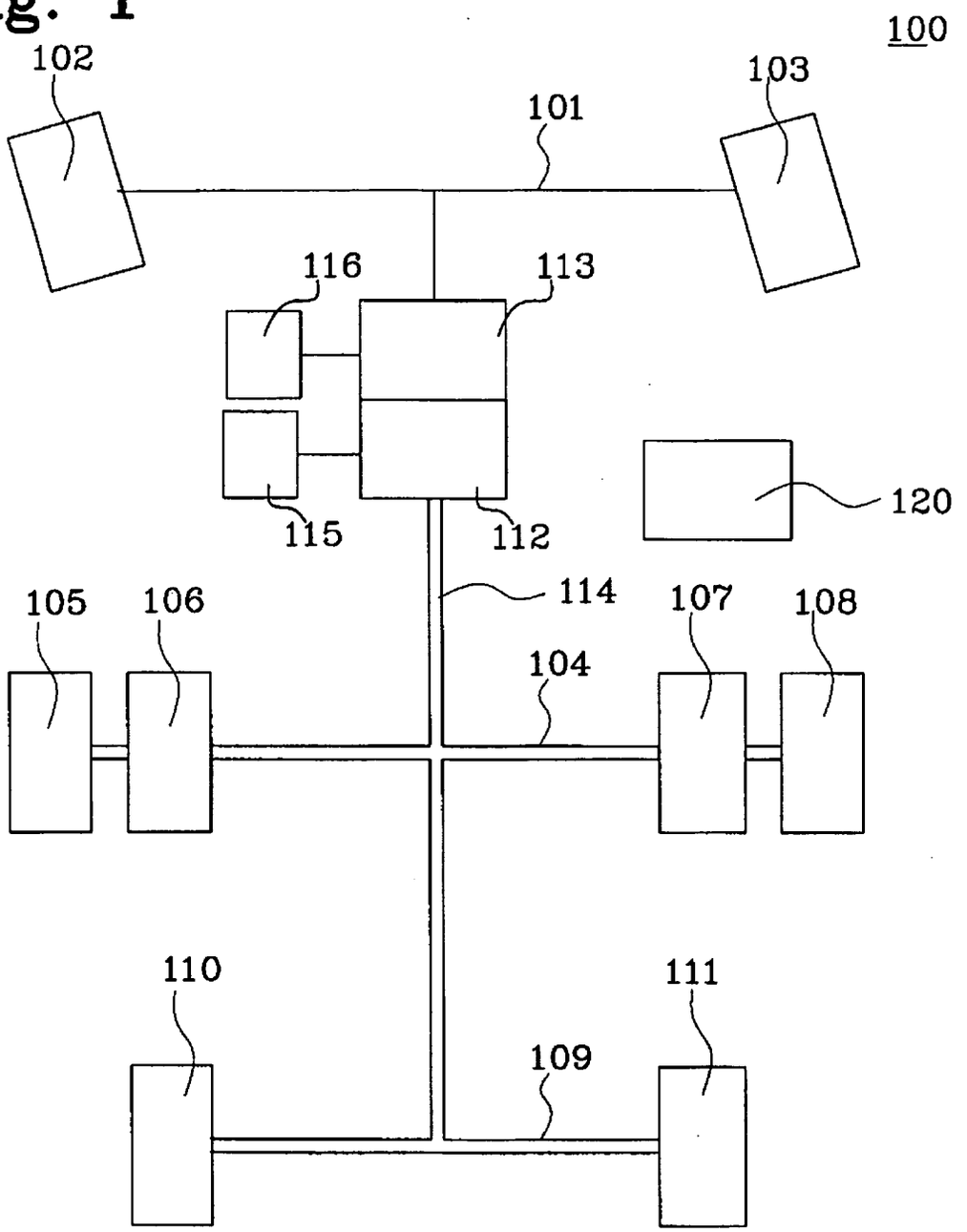

100
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Fig. 2a

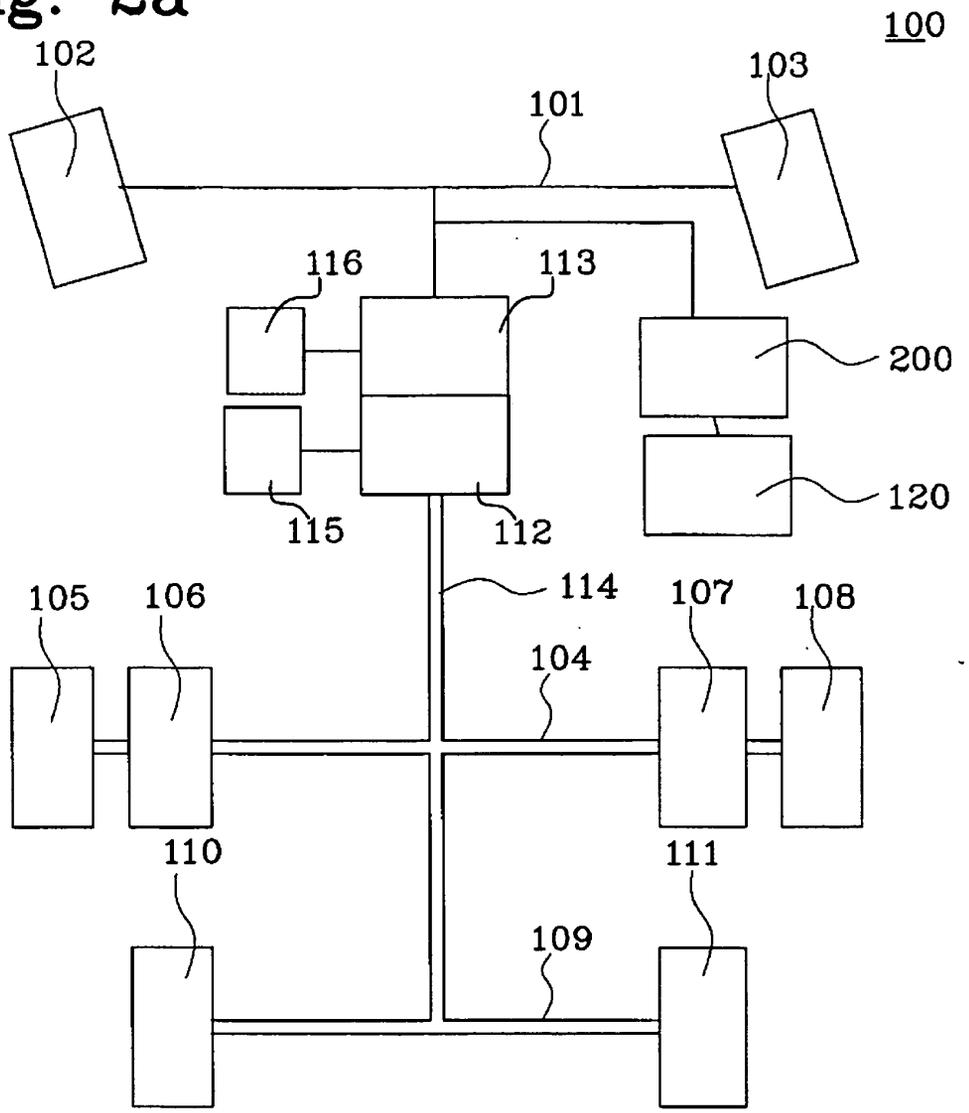
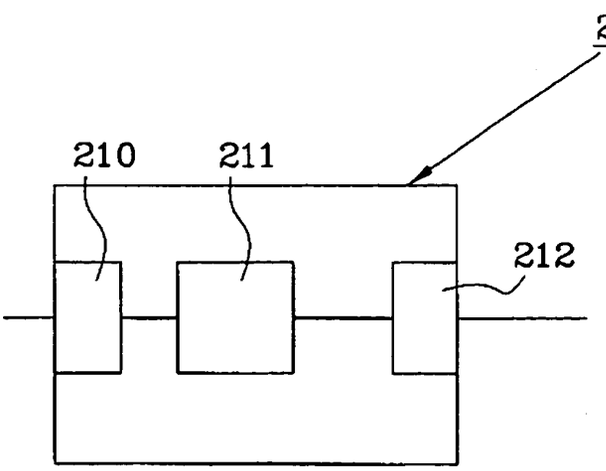

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Fig. 2b


200
210
211
212

REFERENCES CITED IN THE DESCRIPTION

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