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(54) APPARATUSES, SYSTEM AND PROCESS FOR DETECTING ACCIDENTS
VORRICHTUNGEN, SYSTEME UND VERFAHREN ZUR ERMITTeln VON UNFÄLLE
DISPOSITIFS, SYSTÈMES ET MÉTHODES POUR LA DÉTECTION D’ACCIDENTS

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The present invention relates to a system for the personal protection, and in particular a system provided with a main apparatus which can signal an accident to a secondary apparatus connected to a protective garment, for example provided with an airbag, for the activation of the latter. The present invention also relates to vehicles comprising such a main apparatus and a process which can be carried out by such a system.

WO 2010/037931 discloses a system for the personal protection wherein a main apparatus mounted on a motorcycle comprises a main control unit connected to two pairs of main 3-axis acceleration sensors and to a main transceiver for transmitting activation signals on a single radio channel with a frequency of about 900 MHz to a secondary transceiver of a secondary apparatus arranged on a protective garment provided with an airbag. Such known system also comprises a testing device which in case of malfunctions in the main apparatus switches the control unit of the main apparatus from a normal mode to a system fault mode, wherein the protective garment does not work. The secondary transceiver of the secondary apparatus may signal the power-on of the secondary apparatus to the main transceiver of the main apparatus, so that the latter can determine whether the secondary apparatus is off or on. When the main control unit determines an impact of the motorcycle by means of the main sensors, the main apparatus sends through the main transceiver an airbag activation signal to the secondary apparatuses.

US 6018980 discloses a system to determine if a vehicle side part has been deformed after a side impact, which system comprises a main apparatus which compares the frequency components of at least two y-axis acceleration values detected by acceleration sensors arranged in different parts of the vehicle body which move due to a deformation of the vehicle side part after a side impact.

US 2009-127835 A1 discloses a main apparatus provided with a single 3-axis accelerometer which is mounted on a vehicle and is suitable to detect an impact or a slide of this vehicle for inflating an airbag if a threshold value is achieved or exceeded.

Such known systems have reliability problems in case of malfunctions of a transceiver, of interferences between the main apparatus and the secondary apparatuses or of impacts along particular directions, with consequent risks of an undesired activation of the protective garments or of a non-activation thereof in case of accident.

It is therefore an object of the present invention to provide a system free from said disadvantages. Said object is achieved with an apparatus, a system, a process and other products, whose technical features are disclosed in the attached claims.

Thanks to the particular bidirectional connection on two different channels for sending control signals between two transceivers in the main apparatus and two transceivers in the secondary apparatus, the system can also work in case of interferences on one channel and/or of malfunctions of a transceiver, especially if the frequency of the first channel is on a bandwidth, preferably comprised between 2400 and 2483.5 MHz, completely different from the bandwidth of the second channel.

For improving the reliability of the system, one or both the control units of the apparatuses comprise dual-core microprocessors, wherein each core controls a transceiver, so that the system can work properly, thanks to a particular process and/or to particular supervision devices connected to the control units, also in a degraded mode in which the protective garments can be activated though the radio connection on one channel does not work properly.

Particular auxiliary sensors allow, thanks to a particular accident detection process, to activate the protective garments not only in case of impact, with a higher reliability with respect to the known systems and processes for detecting impacts in personal protection systems, but also in case of slide of the vehicle, which is advantageous especially for the motorcycles.

For further improving the reliability of the system, smart-cards containing particular identification codes can be inserted into smart-card readers connected to the control units of the secondary apparatuses, so that these identification codes can be transmitted to the main apparatuses and recognized by the control units of the latter, so that the users can verify the correct connection between the main apparatus and one or more secondary apparatuses without the risk of interferences with other secondary apparatuses. The identification codes preferably comprise sub-codes which allow to recognize the position of the users in the vehicle, for example whether a user is the driver or a passenger, so as to easily distinguish the secondary apparatus having working problems from the secondary apparatus which works properly.

With this arrangement, a smart-card associated to a main apparatus can be inserted into several secondary apparatuses, so that the user can easily change the protective garment with other protective garments while keeping the same vehicle on which the main apparatus is installed.

The secondary apparatuses are preferably provided with vibrating devices, so as to signal status changes to the user without the user being forced to watch a display, so as not to distract him if he drives a vehicle.

Further advantages and features of the apparatuses, the system and the process according to the present invention will become clear to those skilled in the art from the following detailed and non-limiting description of an embodiment thereof with reference to the attached drawings, wherein:
Referring to figures 1 and 2, it is seen that the system comprises a main apparatus 1 suitable for transmitting activation signals and/or control signals to one or more secondary apparatuses 2, 3. The main apparatus 1 can be installed on a vehicle 4, for example a motorcycle, while each secondary apparatus 2, 3 is arranged on a protective garment 5, 6 of a user 7, 8, for example the driver and the passenger of vehicle 4. The protective garments 5, 6 are jackets which can be worn by users 7, 8 and are provided with one or more airbags suitable for being inflated by gas generators controlled by a secondary apparatus 2, 3 in case of accident. The main apparatus 1 is connected to one or more main sensors 9, 10, in particular acceleration sensors on three axes x, y, z mounted on a portion of vehicle 4 which can move with respect to the seats for the users 7, 8, for example a pair of acceleration sensors mounted on the fork of the motorcycle on the two sides of the front wheel.

Axis x is a substantially longitudinal axis, namely substantially parallel to the main displacement direction of vehicle 4, axis y is a substantially transversal and horizontal axis, namely substantially perpendicular to axis x, while axis z is substantially transversal and vertical, namely substantially perpendicular to axis x and axis y. The system is mounted on a motorcycle 4 but it may be mounted also on other land, sea and air vehicles, for example bicycles, motor vehicles, horses, skis, sledges, boats, airplanes, helicopters, parachutes, etc.

Referring to figure 3, it is seen that the main apparatus 1 comprises a main control unit CU1, in particular comprising a dual core microcontroller, for example microcontroller Freescale MC9S12XE-LQFP'144, which is connected to one or more anti-aliasing filters AF1, AF2, AF3 in turn connected to connectors C for connecting the main control unit CU1 to the main sensors 9, 10 and to the auxiliary sensors 11, 12. A first core C11, for example a HCS12 core, of the main control unit CU1 is connected in a bidirectional manner through an interface SPI and serial and/or parallel lines SPL to a first main transceiver T11 suitable for transmitting and receiving control signals and/or activation signals on a first radio channel with a first frequency comprised between 2400 and 2483,5 MHz.

The anti-aliasing filters AF1, AF2, AF3 are preferably Sallen-Key low-pass filters with a cutoff frequency equal to 143 Hz ± 10% and a Q factor equal to 0,74 ± 10%. The analog-to-digital converters A1, A2 sample the acceleration signals Axyz and Ay at a sampling frequency comprised between 1400 and 1600 Hz. The main control unit CU1 can be connected also to a speed sensor SS, for example the same device used for determining the speed in vehicle 4, so that the main control unit CU1 can obtain a longitudinal speed signal Vx corresponding to the speed of vehicle 4. The main control unit CU1 can be connected through a CAN bus also to a CAN (Controller Area Network) interface C11 for the connection to another CAN interface (not shown) present in vehicle 4 and/or to CAN maintenance devices MD for the maintenance of the main apparatus 1.

The main control unit CU1 can be connected also to a speed sensor SS, for example the same device used for determining the speed in vehicle 4, so that the main control unit CU1 can obtain a longitudinal speed signal Vx corresponding to the speed of vehicle 4. The main control unit CU1 can be connected through a CAN bus also to a CAN (Controller Area Network) interface C11 for the connection to another CAN interface (not shown) present in vehicle 4 and/or to CAN maintenance devices MD for the maintenance of the main apparatus 1.
received by the main control unit CU1 through the watchdog line WL and processed by the supervision device SD1. The main control unit CU1 can transmit self-test signals to the main sensors 9, 10 and/or the auxiliary sensors 11, 12 through self-test lines SL. The main control unit CU1 can be connected through a serial bus SB to an input/output controller IO in turn connected to a user interface UI, for example a LCD or LED display and/or a keyboard, so that user 7 can receive and/or transmit information from the main apparatus 1 and/or to the main apparatus 1. The main control unit CU1 and/or the supervision device SD1 can transmit status signals to the input/output controller IO or directly to the user interface UI through lines L1, L2, L3 and L4. Also the user interface UI can transmit status signals to the main control unit CU through a line L5.

A power supply PS1 receives electric current from an external battery EB, for example the same 12V battery of vehicle 4, for supplying a continuous electric current to the components of the main apparatus 1 by means of 3,3V, 5V and 12V lines. The power supply PS1 can also receive an ignition signal K from the ignition key IK of vehicle 4. The power supply PS1 transmits to the main control unit CU1 the ignition signal K and a signal TS corresponding to the voltages on the lines inside and/or outside the main apparatus 1.

Referring to figure 4, it is seen that the secondary apparatus 2, 3 comprises a secondary control unit CU2, in particular comprising a dual core microcontroller, for example microcontroller Freescale MC9S12XE-LQFP112. A first core C21, for example a HCS12 core, of the secondary control unit CU2 is connected in a bidirectional manner through an interface SPI and serial and/or parallel lines SPL to the non-volatile digital memory, for example a flash memory FM. The first core C21 of the secondary control unit CU2 is further connected in a bidirectional manner through an interface SPI and serial and/or parallel lines SPL to a second secondary transceiver T22 suitable for transmitting and receiving control signals and/or activation signals from the second main transceiver T11 of the main apparatus 1 on the first radio channel with a first frequency comprised between 2400 and 2483,5 MHz. A second core C22, for example an Xgate core, of the secondary control unit CU2 is connected in a bidirectional manner through an interface SPI and serial and/or parallel lines SPL to a second secondary transceiver T22 suitable for transmitting and receiving control signals and/or activation signals from the second main transceiver T12 of the main apparatus 1 on the second radio channel with a second frequency different from the first frequency, in particular comprised between 868 and 868,6 MHz or between 902 and 928 MHz. One or both secondary transceivers T21 and/or T22 are connected to the first core C21 or to the second core C22, respectively, by means of interrupt lines IRQ1, IRQ2 for transmitting interrupt signals to cores C21, C22 of the secondary control unit CU2 according to control signals received by the secondary transceivers T21 and/or T22.

The core C21 and the second core C22 of the secondary control unit CU2 are connected through a channel switch CS to at least one firing controller FC, in turn connected through connectors C to one or more gas generators GG 1, GG2 for driving one or more airbags AB1, AB2 of the protective garment 5, 6, by means of activation signals transmitted through firing lines FL from the first core C21 and/or from the second core C22 according to activation signals received by the secondary transceivers T21 and/or T22. The first core C21 and the second core C22 are connected in a bidirectional manner through an interface SPI and serial and/or parallel lines SPL to the channel switch CS for controlling the switching of the firing lines coming from the first core C21 and from the second core C22.

The secondary control unit CU2 of the secondary apparatus 2, 3 is connected to a smart-card reader SR for reading an identification code stored in a smart-card SC ad associated to a reference code stored in a non-volatile memory, in particular in the flash memory FM, of the main apparatus 1. The identification code in the smart-card SC comprises in turn a first sub-code associated to the reference code stored in the main apparatus 1 and a second sub-code which indicates the position of user 7, 8 on vehicle 4, for example the position of driver 7 or passenger 8.

The secondary control unit CU2 of the secondary apparatus 2, 3 can be connected through a CAN (Controller Area Network) interface CI2 for the connection to CAN maintenance devices MD for the maintenance of the secondary apparatus 2, 3.

The secondary control unit CU2 can be connected through a watchdog line WL also to a supervision device SD2, in particular a reset circuit with an adjustable timeout delay such as for example the MAX6753 integrated circuit of Maxim Semiconductor, which can transmit reset signals to the secondary control unit CU2 through a reset line RST. The supervision device SD2 of the secondary apparatus 2, 3 is also connected to the channel switch CS for transmitting a switching signal to the channel switch CS, so as to switch the connection from the firing line FL from the first core C21 to the firing line FL from the second core C22 or even interrupting lines FL for preventing the driving of the protective garment 5, 6 in case of malfunction. The supervision device SD2 is also connected to the second core C22 for transmitting an enabling signal or a disabling signal, which can be sent through the second secondary transceiver T22 to the main apparatus 1.

The secondary control unit CU2 of the secondary apparatus 2, 3 can be connected to a vibrating device VD for signaling to user 7, 8 the status of the secondary apparatus 2, 3, for example malfunctions or anomalies, by means of vibrations of the protective garment 5, 6. The secondary control unit CU2 of the secondary apparatus 2, 3 can be connected by means of a line SE to a switch SW of the protective garment 5, 6 for the activation or the deactivation of the main control unit CU1 through the watchdog line WL and processed by the supervision device SD1. The main control unit CU1 can transmit self-test signals to the main sensors 9, 10 and/or the auxiliary sensors 11, 12 through self-test lines SL. The main control unit CU1 can be connected through a serial bus SB to an input/output controller IO in turn connected to a user interface UI, for example a LCD or LED display and/or a keyboard, so that user 7 can receive and/or transmit information from the main apparatus 1 and/or to the main apparatus 1. The main control unit CU1 and/or the supervision device SD1 can transmit status signals to the input/output controller IO or directly to the user interface UI through lines L1, L2, L3 and L4. Also the user interface UI can transmit status signals to the main control unit CU through a line L5.

A power supply PS1 receives electric current from an external battery EB, for example the same 12V battery of vehicle 4, for supplying a continuous electric current to the components of the main apparatus 1 by means of 3,3V, 5V and 12V lines. The power supply PS1 can also receive an ignition signal K from the ignition key IK of vehicle 4. The power supply PS1 transmits to the main control unit CU1 the ignition signal K and a signal TS corresponding to the voltages on the lines inside and/or outside the main apparatus 1.

Referring to figure 4, it is seen that the secondary apparatus 2, 3 comprises a secondary control unit CU2, in particular comprising a dual core microcontroller, for example microcontroller Freescale MC9S12XE-LQFP112. A first core C21, for example a HCS12 core, of the secondary control unit CU2 is connected in a bidirectional manner through an interface SPI and serial and/or parallel lines SPL to the non-volatile digital memory, for example a flash memory FM. The first core C21 of the secondary control unit CU2 is further connected in a bidirectional manner through an interface SPI and serial and/or parallel lines SPL to a second secondary transceiver T22 suitable for transmitting and receiving control signals and/or activation signals from the first main transceiver T11 of the main apparatus 1 on the first radio channel with a first frequency comprised between 2400 and 2483,5 MHz. A second core C22, for example an Xgate core, of the secondary control unit CU2 is connected in a bidirectional manner through an interface SPI and serial and/or parallel lines SPL to a second secondary transceiver T22 suitable for transmitting and receiving control signals and/or activation signals from the second main transceiver T12 of the main apparatus 1 on the second radio channel with a second frequency different from the first frequency, in particular comprised between 868 and 868,6 MHz or between 902 and 928 MHz. One or both secondary transceivers T21 and/or T22 are connected to the first core C21 or to the second core C22, respectively, by means of interrupt lines IRQ1, IRQ2 for transmitting interrupt signals to cores C21, C22 of the secondary control unit CU2 according to control signals received by the secondary transceivers T21 and/or T22.

The core C21 and the second core C22 of the secondary control unit CU2 are connected through a channel switch CS to at least one firing controller FC, in turn connected through connectors C to one or more gas generators GG 1, GG2 for driving one or more airbags AB1, AB2 of the protective garment 5, 6, by means of activation signals transmitted through firing lines FL from the first core C21 and/or from the second core C22 according to activation signals received by the secondary transceivers T21 and/or T22. The first core C21 and the second core C22 are connected in a bidirectional manner through an interface SPI and serial and/or parallel lines SPL to the channel switch CS for controlling the switching of the firing lines coming from the first core C21 and from the second core C22.

The secondary control unit CU2 of the secondary apparatus 2, 3 is connected to a smart-card reader SR for reading an identification code stored in a smart-card SC ad associated to a reference code stored in a non-volatile memory, in particular in the flash memory FM, of the main apparatus 1. The identification code in the smart-card SC comprises in turn a first sub-code associated to the reference code stored in the main apparatus 1 and a second sub-code which indicates the position of user 7, 8 on vehicle 4, for example the position of driver 7 or passenger 8.

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The secondary control unit CU2 can be connected through a watchdog line WL also to a supervision device SD2, in particular a reset circuit with an adjustable timeout delay such as for example the MAX6753 integrated circuit of Maxim Semiconductor, which can transmit reset signals to the secondary control unit CU2 through a reset line RST. The supervision device SD2 of the secondary apparatus 2, 3 is also connected to the channel switch CS for transmitting a switching signal to the channel switch CS, so as to switch the connection from the firing line FL from the first core C21 to the firing line FL from the second core C22 or even interrupting lines FL for preventing the driving of the protective garment 5, 6 in case of malfunction. The supervision device SD2 is also connected to the second core C22 for transmitting an enabling signal or a disabling signal, which can be sent through the second secondary transceiver T22 to the main apparatus 1.

The secondary control unit CU2 of the secondary apparatus 2, 3 can be connected to a vibrating device VD for signaling to user 7, 8 the status of the secondary apparatus 2, 3, for example malfunctions or anomalies, by means of vibrations of the protective garment 5, 6. The secondary control unit CU2 of the secondary apparatus 2, 3 can be connected by means of a line SE to a switch SW of the protective garment 5, 6 for the activation or the deactivation of...
the secondary control unit CU2.

A power supply PS2 of the secondary apparatus 2, 3 is connected to an external battery EB, for example the same 12V battery of vehicle 4 and/or to an internal 3,2V battery IB, preferably rechargeable by the power supply PS2, which supplies a continuous electric current to the components of the secondary apparatus 2, 3 by means of 3,3V, 5V, 12V and 24V lines. The control of the recharge of the internal battery IB is carried out by the secondary control unit CU2 by means of lines L6, L7 connecting the power supply PS2 to the secondary control unit CU2. The power supply PS2 is connected to the firing controller FC by means of a line which carries a voltage sufficient for driving the gas generators GG1, GG2, in particular a 24V line. The voltage on the 24V line can be activated or deactivated by the secondary control unit CU2 and/or by the supervision device SD2 by means of voltage enabling and/or disabling signals which are transmitted to the power supply PS2 through lines FE, FD. The status of batteries EB and/or IB connected to the power supply PS2 can be controlled by pushing a button BB connected to the power supply PS2 and/or to the secondary control unit CU2. When user 7, 8 pushes button BB, the power supply PS2 sends through a line BC a status signal to the secondary control unit CU2, which in turn turns on a battery light BL according to this status signal.

The power supply PS2 is connected to switch SW by means of line SE for turning on and off the secondary apparatus 2, 3. The power supply PS2 transmits to the secondary control unit CU2 a signal TS corresponding to the temperature of the power supply PS2. The secondary apparatus 2, 3 is connected with the external components through a plurality of connectors C. Further control lines connect the power supply PS2 to the secondary control unit CU2 for controlling the voltages on the lines inside and/or outside the secondary apparatus 2, 3.

Referring to figure 5, it is seen that when the main apparatus 1 and/or the secondary apparatuses 2, 3 are turned on, the system is in an initial mode IM, after which the control units CU1, CU2 of the main apparatus 1 and of the secondary apparatuses 2, 3 carry out a check phase CHK for verifying that all the components of the main apparatus 1 and of the secondary apparatuses 2, 3 work properly. The control units CU1, CU2 of the main apparatus 1 and of the secondary apparatuses 2, 3 work in a normal mode NM, in which the main transceivers T11, T12 of the main apparatus 1 are connected with the secondary transceivers T21, T22 of one or more secondary apparatuses 2, 3, if they pass the check phase CHK and they are not in a maintenance mode MM, which is detected if one or more maintenance devices MD are connected to the control units CU1 and/or CU2.

If the control units CU1, CU2 of the main apparatus 1 and of the secondary apparatuses 2, 3 do not pass the check phase CHK and are in the maintenance mode MM, the main control unit CU1 shows on the user interface UI a system fault signal SFS and, if airbags AB1, AB2 of one or both secondary apparatuses 2, 3 have been activated, also a maintenance signal MMS. At the same time, the secondary control unit CU2 of the secondary apparatuses 2, 3 drives the vibrating device VD.

During the maintenance mode MM the control units CU1, CU2 of the main apparatus 1 and of the secondary apparatuses 2, 3 transmit and/or receive data from the maintenance devices MD, after which they switch to a stop mode SM, in which the main apparatus 1 and the secondary apparatuses 2, 3 are deactivated.

During the normal mode NM the control units CU1, CU2 of the main apparatus 1 and of the secondary apparatuses 2, 3 carry out a normal working cycle, in which the control unit CU1 of the main apparatus 1 may transmit an activation signal to the secondary apparatuses 2, 3 for activating airbags AB1, AB2 if an accident is detected, but also verify whether a system fault occurred, in which case they switch to a system fault mode SFM, or whether a system degradation occurred, in which case they switch to a degraded mode DM, or whether a system interruption occurred, in which case they switch to the stop mode SM. During the degraded mode DM the main control unit CU1 shows on the user interface UI a degraded mode signal DMS. At the same time, the secondary control unit CU2 of the secondary apparatuses 2, 3 drives the vibrating device VD.

During the degraded mode DM the control units CU1, CU2 of the main apparatus 1 and of the secondary apparatuses 2, 3 carry out a normal working cycle, in which the control unit CU1 of the main apparatus 1 may still transmit an activation signal to the secondary apparatuses 2, 3 for activating airbags AB1, AB2 if an accident is detected, but also verify whether a system fault occurred, in which case they switch to a system fault mode SFM, or whether a system interruption occurred, in which case they switch to the stop mode SM. In the degraded mode DM the main control unit CU1 shows on the user interface UI a degraded mode signal DMS. At the same time, the secondary control unit CU2 of the secondary apparatuses 2, 3 drives the vibrating device VD. The control units CU1, CU2 of the main apparatus 1 and of the secondary apparatuses 2, 3 switch to the system fault mode SFM also if they do not pass the check phase CHK and if they are not in the maintenance mode MM. In the system fault mode SFM the main control unit CU1 turns off on the user interface UI the degraded mode signal DMS, if it was on, and turns on on the user interface UI the system fault signal SFS. At the same time, the secondary control unit CU2 of the secondary apparatuses 2, 3 drives the vibrating device VD. In the system fault mode SFM the main control unit CU1 shows on the user interface UI also a maintenance signal MMS, if airbags AB1, AB2 of one or both secondary apparatuses 2, 3 have been activated. During the system fault mode SFM the control units CU1, CU2 of the main apparatus 1 and of the secondary apparatuses 2, 3 verify whether a system interruption occurred, in which case they switch to the stop mode SM.

Referring to figure 6, it is seen that the main apparatus 1 and the secondary apparatuses 2, 3, in the respective initial mode IM1, IM2, IM3, carry out a power-on phase ON1, ON2, ON3 and the check phase CHK1, CHK2, CHK3 in
the above described way. After the initial mode IM1, the main apparatus 1 in a first normal mode NM1 sends control
signals on the first radio channel through the first main transceiver T11 and on the second radio channel through the
second main transceiver T12 for verifying the power-on of the secondary apparatuses 2, 3. If these control signals are
received by the first secondary transceiver T21 and by the second secondary transceiver T22 of the secondary appa-
ratuses 2 and/or 3 which have carried out the initial mode IM2 and/or IM3, the main apparatus 1 and the secondary
apparatuses 2 and/or 3 carry out a pairing phase PP12 and/or PP13, respectively, in which the secondary apparatuses
2 and/or 3 transmit to the main apparatus 1 the respective identification codes stored in the smart-cards SC inserted
in the respective smart-card readers SR, so that the control unit CU1 of the main apparatus 1 can compare the identification
codes received by the secondary apparatuses 2 and/or 3 with the reference code stored in the non-volatile memory FM.
If this comparison is positive, the main apparatus 1 is paired with the secondary apparatuses 2 and/or 3, so that the
control unit CU1 of the main apparatus 1 periodically transmits and receives control signals with the control unit CU2 of the
secondary apparatuses 2 and/or 3 through transceivers T11, T12, T21 and T22. After the pairing phase PP12 and/or
PP13 the secondary apparatuses 2 and/or 3 are connected with the main apparatus 1 in an enabled protection phase
EP12 and/or EP13, in which the control unit CU2 of the secondary apparatuses 2 and/or 3 can activate airbags AB1,
AB2 according to activation signals transmitted by the main apparatus 1. The enabled protection phase EP12 and/or
EP13 is carried out in a second normal mode NM12 in which the main apparatus 1 and only the first secondary apparatus
2 are on, or in a third normal mode NM13 in which the main apparatus 1 and only the second secondary apparatus 3
are on, or in a fourth normal mode NM123 in which the main apparatus 1 and both secondary apparatuses 2, 3 are on.
In all the normal modes NM1, NM12, NM13 and NM123 the main apparatus 1 sends control signals from the first main
transceiver T11 and/or from the second main transceiver T12 for verifying the power-on of the secondary apparatuses
2, 3. If the first secondary transceiver T21 and the second secondary transceiver T22 of the secondary apparatuses 2
and/or 3 do not reply to the control signals transmitted by the main apparatus 1, the latter disables the pairing with the
secondary apparatus 2 and/or 3 which does not reply, switching then from the fourth normal mode NM123 to the second
or third normal mode NM12 or NM13, or switching from the second or third normal mode NM12 or NM 13 to the first
normal mode NM1.

[0036] Referring to figure 7, it is seen that in the second, third or fourth normal mode NM12, NM13 or NM123, namely
in a normal mode in which the main apparatus 1 is paired with at least one secondary apparatus 2, 3 in an enabled
protection phase EP12 and/or EP13, the main control unit CU1 of the main apparatus 1 in a signal acquisition phase
SAP acquires the acceleration signals Axyz and/or Ay from the main sensors 9, 10 and/or from the auxiliary sensors
11, 12 through the anti-aliasing filters AF1, AF2, AF3. If at least one of the values of the signals Axyz and/or Ay is outside
a range of correct values stored in a non-volatile memory FM and/or FRAM, the main control unit CU1 of the main
apparatus 1 verifies the proper working of the of the main sensors 9, 10 and/or of the auxiliary sensors 11, 12 by sending
a self-test signal through the self-test lines SL. If both main sensors 9, 10 or both auxiliary sensors 11, 12 do not reply to
the self-test signal, the main control unit CU1 switches the main apparatus 1 to the system fault mode SFM, otherwise
if only one of the main sensors 9, 10 and/or of the auxiliary sensors 11, 12 replies to the self-test signal, the main control
unit CU1 switches the main apparatus 1 to a first degraded mode DM1, in which the main sensor 9, 10 and/or the auxiliary
sensor 11, 12 which does not reply to the self-test signal is excluded.

[0037] If instead the values of the acceleration signals Axyz and/or Ay are within a valid range, the main control unit
CU1 of the main apparatus 1 in an impact detection phase IDP detects whether an impact occurred according to the
acceleration signals Axyz sent by the main sensors 9, 10. If an impact is not detected in the impact detection phase IDP,
the main control unit CU1 in a speed detection phase VDP detects whether vehicle 4 is moving with a longitudinal speed
Vx higher than a speed threshold VT, for example comprised between 2 and 10 m/s, stored in a non-volatile memory
FM and/or FRAM. The main control unit CU1 of the main apparatus 1 can obtain the longitudinal speed Vx by means of
the speed sensor SS, by means of other speed or acceleration sensors or in another way, in particular by verifying
whether the transversal accelerations Ay and/or the vertical accelerations Az in the acceleration signals Axyz sent by the
main sensors 9, 10 exceed acceleration thresholds stored in a non-volatile memory FM and/or FRAM. If the longitudinal
speed Vx of vehicle 4 is higher than the speed threshold VT, the main control unit CU1 of the main apparatus 1 in a
slide detection phase SDP detects whether a slide occurred according to the acceleration signals Ay sent by the auxiliary
sensors 11, 12. If an impact is detected in the impact detection phase IDP or a slide is detected in the slide detection
phase SDP, the main control unit CU1 of the main apparatus 1 in an accident signaling phase ASP sends an activation
signal AS to the secondary apparatuses 2, 3 for a number k of times through the first main transceiver T11 and/or the
second main transceiver T12, after which, in an accident memory phase AMP, stores in the non-volatile memory FRAM
all the available data relating to the moment of the accident detection and/or to the acceleration signals Axyz and/or Ay
sent by the main sensors 9, 10 and/or by the auxiliary sensors 11, 12 in the moments preceding the accident, for example
during a period MT longer than 250 ms before the accident.

[0038] The acceleration signals Axyz and/or Ay are stored at each sampling cycle into a circular buffer in the non-
volatile memory FRAM, so that the accident memory phase AMP consists of the stoppage of the writing in the non-
volatile memory FRAM, which thus is accessible in a subsequent moment by means of a maintenance device MD for
detecting the causes of the accident.

When the first secondary transceiver T21 and/or the second secondary transceiver T22 of the secondary apparatuses 2, 3 receive the activation signal AS from the main apparatus 1, the secondary control unit CU2 of the secondary apparatuses 2, 3 sends the activation signals through the firing lines FL to the gas generators GG1, GG2 for activating airbags AB1, AB2.

Referring to figure 8, it is seen that in the impact detection phase IDP the acceleration signals Axyz sent by the main sensors 9, 10 and filtered by the anti-aliasing filters AP1, AF2 are processed by the main control unit CU1 of the main apparatus 1 so as to obtain axial acceleration values Ax, Ay and Az on the three axes x, y and z, which are in particular obtained with a mean, for example an arithmetic mean, of the three pairs of axial accelerations Ax1 and Ax2, Ay1 and Ay2, Az1 and Az2, oriented along axes substantially parallel, of the two acceleration signals Axyz sent by the main sensors 9, 10. One or more axial acceleration values Ax, Ay and Az are filtered by the main control unit CU1 by means of first high-pass filter stages HPF1 having a cutoff frequency comprised between 0.5 and 15 Hz, in particular between 4 and 6 Hz, so as to cancel possible axial acceleration values which depend only on the movement of vehicle 4, after which the main control unit CU1 calculates a direction value D proportional to the square of the vertical acceleration Az and inversely proportional to the sum of the squares of the three axial accelerations Ax, Ay and Az, in particular with the formula D=Az²/(Ax²+Ay²+Az²). The direction value D is filtered by the main control unit CU1 by a first low-pass filter stage LPF1 having a cutoff frequency comprised between 1 and 100 Hz, in particular between 20 and 40 Hz, so as to obtain a filtered direction value D which is not influenced by anomalous peaks in the acceleration signals Axyz. The main control unit CU1 calculates an energy threshold ET and a stress threshold ST by means of the filtered direction value D, in particular through a pair of energy constants ET1, ET2 and a pair of stress constants ST1, ST2, which are obtained in an experimental manner and are stored in a non-volatile memory FM and/or FRAM of the main apparatus 1. The energy threshold ET and the stress threshold ST are proportional to the square of the filtered direction value D, to a constant ET2 or ST2, and/or to the difference of the pairs of constants ET1 and ET2, ST1 and ST2, in particular by calculating an energy modulus EM according to the formula EM=(IAx² + LAy²), wherein IAx is the stress intensity SI proportional to the sum of the squares of the axial acceleration values Ax, Ay, for example with the formula SI=Ax²+Ay², after which the value of the stress intensity SI is held by a peak holder phase PH which limits the slope with which this value returns to the value obtained by the acceleration values detected by the main sensors 9, 10 after a peak, so as to compensate the delay between the calculations of the stress intensity SI and of the energy modulus EM, which delay is caused by the integration operation in the integration phases IPx, IPy. A possible implementation of the peak holder phase PH in the main control unit CU1 can be the following:

\[
\text{if (SI(t)<(SI(t-1)-DCY)) then (SI(t)= (SI(t-1)-DCY)),}
\]

wherein SI(t) is the stress intensity SI during the time and DCY is a decay constant greater than 100 g²/ms, in particular comprised between 990 and 1010 g²/ms, wherein g is the acceleration of gravity and ms are milliseconds.

If the main control unit CU1 verifies that at a given instant the stress intensity SI is greater than the stress threshold ST and simultaneously the energy modulus EM is greater than the energy threshold ET, the main control unit CU1 of the main apparatus 1 sends the activation signal AS to the control units CU2 of the secondary apparatuses 2, 3. Referring to figure 9, it is seen that in the slide detection phase SDP the axial acceleration signals Ay1, Ay2 sent by the auxiliary sensors 11, 12 and filtered by the anti-aliasing filter AF3 are processed by the main control unit CU1 of the main apparatus 1 in second low-pass filter stages LPF2 having a cutoff frequency comprised between 100 and 200 Hz, in particular between 140 and 160 Hz, so as to eliminate possible anomalous peaks. If however after a given waiting time WT, for example comprised between 100 and 300 ms, signals Ay1 or Ay2 are always greater than an acceleration threshold AT, for example comprised between 0.5 and 1 g (acceleration of gravity), stored in a non-volatile memory FM and/or FRAM, then the main control unit CU1 of the main apparatus 1 sends the activation signal AS to the control units CU2 of the secondary apparatuses 2, 3. Referring to figure 10, it is seen that in the normal mode NM the control units CU1, CU2 of the main apparatus
In particular, the first core C11 of the main control unit CU1 of the main apparatus 1 receives and processes the acceleration signals Ax, Ay and sends on the first radio channel through the first main transceiver T11 the control signals to the first secondary transceiver T21 of the secondary apparatuses 2, 3, in which the first core C21 of the secondary control unit CU2 receives the control signals on the first radio channel from the first secondary transceiver T21 and sends an activation signal to the gas generators GG1, GG2 if it receives from the main apparatus 1 also activation signals. In the meanwhile, the second core C12 of the main control unit CU1 of the main apparatus 1 and the second core C22 of the secondary control unit CU2 of the secondary apparatuses 2, 3 periodically send on the second radio channel control signals from the second main transceiver T12 and from the second secondary transceiver T22, respectively, which control signals are received by the second secondary transceiver T22 and by the second main transceiver T12, respectively, for being processed by the second core C22 of the secondary control unit CU2 and by the second core C12 of the main control unit CU1.

If the first main transceiver T11 and/or the first secondary transceiver T21 do not receive the control signals on the first radio channel, the main control unit CU1 of the main apparatus 1 and/or the secondary control unit CU2 of the secondary apparatuses 2, 3 send on the second radio channel a degraded mode signal DMS from the second main transceiver T12 and/or from the secondary transceiver T22 to the secondary apparatuses 2, 3 and/or to the main apparatus 1, respectively, so that the control units CU1, CU2 of the main apparatus 1 and of the secondary apparatuses 2, 3 switch from the normal mode NM to a second degraded mode DM2, in which the control signals are transmitted on the second radio channel by the second main transceiver T12 of the main apparatus 1 and/or by the second secondary transceiver T22 of the secondary apparatuses 2, 3. If also the second main transceiver T12 and the second secondary transceiver T22 do not receive the control signals on the second radio channel, the control units CU1, CU2 of the main apparatus 1 and of the secondary apparatuses 2, 3 switch from the second degraded mode DM2 to the system fault mode SFM.

If instead the first main transceiver T11 and the first secondary transceiver T21 receive the control signals on the first radio channel, the main control unit CU1 of the main apparatus 1 and/or the secondary control unit CU2 of the secondary apparatuses 2, 3 send on the first radio channel a degraded mode signal DMS from the first main transceiver T11 and/or from the first secondary transceiver T21 to the secondary apparatuses 2, 3 and/or to the main apparatus 1, respectively, so that the control units CU1, CU2 of the main apparatus 1 and of the secondary apparatuses 2, 3 switch from the normal mode NM to a third degraded mode DM3, in which the control signals are transmitted on the first radio channel by the first main transceiver T11 of the main apparatus 1 and/or by the first secondary transceiver T21 of the secondary apparatuses 2, 3, while no control signals are transmitted on the second radio channel. If also the first main transceiver T11 and the first secondary transceiver T21 do not receive the control signals on the first radio channel, the control units CU1, CU2 of the main apparatus 1 and of the secondary apparatuses 2, 3 will switch from the third degraded mode DM3 to the system fault mode SFM.

Possible modifications and/or additions may be made by those skilled in the art to the hereinafore disclosed and illustrated embodiment while remaining within the scope of the following claims. In particular, further embodiments of the invention may comprise the technical features of one of the following claims with the addition of one or more technical features, taken singularly or in any mutual combination, disclosed in the text and/or illustrated in the drawings.

Claims

1. Process for detecting accidents, characterized in that it comprises the following operating steps:

   - obtaining at least two axial accelerations (Ax, Ay, Az) comprising a first axial acceleration (Ax) oriented along a first axis (x) and a second axial acceleration (Ay) oriented along a second axis (y) which is substantially perpendicular to the first axis (x);
   - integrating at least the first axial acceleration (Ax) and the second axial acceleration (Ay) of said axial accelerations (Ax, Ay, Az) for obtaining at least two axial acceleration integral values (IAx, IAy);
   - calculating an energy modulus (EM) according to the two axial acceleration integral values (IAx, IAy);
   - comparing the energy modulus (EM) with an energy threshold (ET).

2. Process according to the previous claim, characterized in that it comprises the following further operating steps:

   - calculating a stress intensity (SI) according to the first axial acceleration (Ax) and to the second axial acceleration (Ay);
3. Process according to the previous claim, characterized in that the stress intensity (SI) is proportional to the sum of the squares of the two axial accelerations (Ax, Ay).

4. Process according to claim 2 or 3, characterized in that the stress intensity (SI) is held by a peak holder (PH).

5. Process according to the previous claim, characterized in that the peak holder (PH) is implemented in the following way:

   \[ \text{if } (\text{SI}(t)<(\text{SI}(t-1)-DCY)) \text{ then } (\text{SI}(t)=(\text{SI}(t-1)-DCY)); \]
   \[ \text{wherein SI(t) is the stress intensity and DCY is a decay constant greater than 100 g}^2/\text{ms}, \text{in particular comprised between 990 and 1010 g}^2/\text{ms}. \]

6. Process according to one of the previous claims, characterized in that one or more axial accelerations (Ax, Ay, Az) are filtered by means of high-pass filters (HPF1) having a cutoff frequency comprised between 0.5 and 15 Hz, in particular between 4 and 6 Hz.

7. Process according to one of the previous claims, characterized in that the energy threshold (ET) and/or the stress threshold (ST) are calculated according to a direction value (D) depending on the three axial accelerations (Ax, Ay, Az).

8. Process according to the previous claim, characterized in that the direction value (D) is proportional to the square of the third axial acceleration (Az) and inversely proportional to the sum of the squares of the three axial accelerations (Ax, Ay, Az).

9. Process according to claim 7 or 8, characterized in that the direction value (D) is filtered by a low-pass filter (LPF1) having a cutoff frequency comprised between 1 and 100 Hz, in particular between 20 and 40 Hz.

10. Process according to one of the previous claims, characterized in that the energy threshold (ET) and/or the stress threshold (ST) also depend on a pair of energy constants (ET1, ET2) and/or on a pair of stress constants (ST1, ST2).

11. Process according to the previous claim, characterized in that the energy threshold (ET) and/or the stress threshold (ST) are proportional to the square of the direction value (D), to an energy or stress constant (ET2, ST2) and/or to the difference of the pair of energy or stress constants (ET1, ET2, ST1, ST2).

12. Process according to the previous claim, characterized in that the energy threshold (ET) is obtained by means of the formula \( \text{ET}=\text{ET}2+D^2(\text{ET}1-\text{ET}2) \), wherein ET is the energy threshold, ET1 and ET2 are the energy constants and D is the direction value.

13. Process according to claim 11 or 12, characterized in that the stress threshold (ST) is obtained by means of the formula \( \text{ST}=\text{ST}2+D^2(\text{ST}1-\text{ST}2) \), wherein ST is the stress threshold, ST1 and ST2 are the stress constants and D is the direction value.

14. Process according to one of the previous claims, characterized in that the axial acceleration integral values (IAx, IAy) are filtered by one or more high-pass filters (HPF2) having a cutoff frequency comprised between 0.05 and 1 Hz.

15. Process according to one of the previous claims, characterized in that on or more of the axial accelerations (Ax, Ay, Az) are obtained with a mean, in particular an arithmetic mean, of at least two axial accelerations (Ax1, Ax2, Ay1, Ay2, Az1, Az2) oriented along substantially parallel axes.

16. Process according to one of claims 2 to 15, characterized in that an accident is detected if the stress intensity (SI) is greater than the stress threshold (ST) and the energy modulus (EM) is greater than the energy threshold (ET).

17. Process according to one of the previous claims, characterized in that an accident is detected if one or more axial accelerations (Ay1, Ay2) after a waiting time (WT) are always greater than an acceleration threshold (AT).

18. Process according to one of the previous claims, characterized in that said axial accelerations (Ay1, Ay2) are
second axial accelerations.

19. Process according to claim 17 or 18, characterized in that said axial accelerations (Ay1, Ay2) are filtered by one or more low-pass filters (LPF2) having a cutoff frequency comprised between 100 and 200 Hz, in particular between 140 and 160 Hz.

20. Process according to one of claims 17 to 19, characterized in that an accident is detected if also a longitudinal speed value (Vx) is greater than a speed threshold (VT).

21. Process according to the previous claim, characterized in that the speed threshold (VT) is comprised between 2 and 10 m/s.

22. Process according to claim 20, characterized in that the longitudinal speed value (Vx) is calculated according to the second axial acceleration (Ay) and/or to the third axial acceleration (Az).

23. Process according to one of claims 17 to 22, characterized in that the acceleration threshold (AT) is comprised between 0,5 and 1 g.

24. Process according to one of claims 17 to 23, characterized in that the waiting time (WT) is comprised between 100 and 300 ms.

25. Process according to one of the previous claims, characterized in that the first axial acceleration (Ax) is oriented along a first axis (x) substantially parallel to the main displacement direction of a vehicle (4), the second axial acceleration (Ay) is oriented along a second axis (y) substantially horizontal and substantially perpendicular to the first axis (x), and/or the third axial acceleration (Az) is oriented along a third axis (z) substantially perpendicular to the first axis (x) and to the second axis (y).

26. Process according to one of the previous claims, characterized in that the energy modulus (EM) is proportional to the sum of the squares of the axial acceleration integral values (IAx, 1Ay).

27. Main apparatus (1) for the personal protection, which comprises a main control unit (CU1) which is connected to one or more main sensors (9, 10) for detecting an impact of a vehicle (4) according to signals (Axyz) sent by the main sensors (9, 10), characterized in that the main control unit (CU1) is also connected to one or more auxiliary sensors (11, 12) for detecting a slide of the vehicle (4) according to signals (Ay) sent by the auxiliary sensors (11, 12), wherein said sensors (9, 10, 11, 12) are acceleration sensors on one or more axes (x, y, z) substantially perpendicular to each other and send axial acceleration signals (Axyz, Ay) to the main control unit (CU1).

28. Main apparatus (1) according to the previous claim, characterized in that the main sensors (9, 10) are suitable for being mounted on a portion of a vehicle (4) which can move with respect to the seats for the users (7, 8) of the vehicle (4).

29. Main apparatus (1) according to claim 27 or 28, characterized in that the auxiliary sensors (11, 12) are suitable for being mounted on a portion of a vehicle (4) which is fixed with respect to the seats for the users (7, 8) of the vehicle (4).

30. Main apparatus (1) according to one of claims 27 to 29, characterized in that from said axial acceleration signals (Axyz, Ay) the main control unit (CU1) obtains at least two axial accelerations (Ax, Ay, Az) comprising a first axial acceleration (Ax) oriented along a first axis (x) and a second axial acceleration (Ay) oriented along a second axis (y) which is substantially perpendicular to the first axis (x).

31. Main apparatus (1) according to the previous claim, characterized in that the acceleration signals (Axyz, Ay) are stored in a non-volatile memory (FRAM) connected to the main control unit (CU1).

32. Main apparatus (1) according to one of claims 27 to 31, characterized in that the main control unit (CU1) is also connected to a speed sensor (SS) which sends to the main control unit (CU1) longitudinal speed signals (Vx) relating to the vehicle (4).

33. Main apparatus (1) according to one of claims 27 to 32, characterized in that the main control unit (CU1) implements
the process according to one of claims 1 to 26.

34. Vehicle (4), characterized in that it comprises a main apparatus (1) according to one of claims 27 to 33.

35. Motorcycle (4) comprising a fork of the front wheel and a saddle, characterized in that it comprises a main apparatus (1) according to one of claims 27 to 33, wherein the main sensors (9, 10) are mounted on the fork on the two sides of the front wheel and the secondary sensors (11, 12) are mounted under the saddle.

36. System for the personal protection, characterized in that it comprises a main apparatus (1) according to one of claims 27 to 33, which main apparatus (1) is suitable for transmitting an activation signal (AS) in case of impact or slide of a vehicle (4) to one or more secondary apparatuses (2, 3) comprising a firing controller (FC) connected to one or more gas generators (GG1, GG2) connected to one or more airbags (AB1, AB2).

Patentansprüche

1. Verfahren zum Erkennen von Unfällen, dadurch gekennzeichnet, dass es die folgenden Betriebsschritte umfasst:

   - Gewinnen wenigstens zweier Axialbeschleunigungen (Ax, Ay, Az), umfassend eine erste, entlang einer ersten Achse (x) orientierte Axialbeschleunigung (Ax) und eine zweite Axialbeschleunigung (Ay) entlang einer zweiten Achse (y), die substantiell rechtwinklig zu der ersten Achse (x) ist;
   - Integrieren von wenigstens der ersten Axialbeschleunigung (Ax) und der zweiten Axialbeschleunigung (Ay) aus den besagten Axialbeschleunigungen (Ax, Ay, Az), um wenigstens zwei Axialbeschleunigungs-Integralwerte (IAx, IAy) zu gewinnen;
   - Berechnen eines Energiemoduls (EM) gemäß den zwei Axialbeschleunigungs-Integralwerten (IAx, IAy);
   - Vergleichen des Energiemoduls (EM) mit einem Energie-Schwellwert (ET).

2. Verfahren nach dem vorangehenden Anspruch, dadurch gekennzeichnet, dass es die folgenden, weiteren Betriebsschritte umfasst:

   - Berechnen einer Belastungsintensität (SI) gemäß der ersten Axialbeschleunigung (Ax) und der zweiten Axialbeschleunigung (Ay);
   - Vergleichen der Belastungsintensität (SI) mit einem Belastungs-Schwellwert (ST).

3. Verfahren nach dem vorangehenden Anspruch, dadurch gekennzeichnet, dass die Belastungsintensität (SI) proportional zu der Summe aus den Quadraten der zwei Axialbeschleunigungen (Ax, Ay) ist.

4. Verfahren nach Anspruch 2 oder 3, dadurch gekennzeichnet, dass die Belastungsintensität (SI) mit einem Spitzenwert-Halter (PH) festgehalten wird.

5. Verfahren nach dem vorangehenden Anspruch, dadurch gekennzeichnet, dass der Spitzenwert-Halter (PH) auf die folgende Weise implementiert ist:

   wenn (SI(t) < SI(t-1) - DCY)) dann SI(t) = SI(t-1) - DCY);

wobei SI(t) die Belastungsintensität ist und DCY eine Abklingkonstante größer als 100 g²/ms, insbesondere zwischen 990 und 1010 g²/ms.

6. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass ein oder mehrere Beschleunigungen (Ax, Ay, Az) gefiltert werden mittels Hochpassfiltern (HPF1) mit einer Grenzfrequenz zwischen 0,5 und 15 Hz, insbesondere zwischen 4 und 6 Hz.

7. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass der Energie-Schwellwert (ET) und/oder der Belastungs-Schwellwert (ST) anhand eines Richtungswertes (D) in Abhängigkeit von den drei Axialbeschleunigungen berechnet werden.
8. Verfahren nach dem vorangehenden Anspruch, **durchdurch gekennzeichnet, dass** der Richtungswert (D) proportional zu dem Quadrat der dritten Axialbeschleunigung (Az) ist sowie umgekehrt proportional zu der Summe der Quadrate der drei Axialbeschleunigungen (Ax, Ay, Az).

9. Verfahren nach Anspruch 7 oder 8, **durchdurch gekennzeichnet, dass** der Richtungswert (D) mittels eines Tiefpassfilters (LPF1) mit einer Grenzfrequenz zwischen 1 und 100 Hz, insbesondere zwischen 20 und 40 Hz, gefiltert wird.

10. Verfahren nach einem der vorhergehenden Ansprüche, **durchdurch gekennzeichnet, dass** der Energie-Schwellwert (ET) und/oder der Belastungs-Schwellwert (ST) auch von einem Paar von Energie-Konstanten (ET1, ET2) und/oder von einem Paar von Belastungskonstanten abhängen.

11. Verfahren nach dem vorangehenden Anspruch, **durchdurch gekennzeichnet, dass** der Energie-Schwellwert (ET) und/oder der Belastungs-Schwellwert (ST) auch proportional zu dem Quadrat des Richtungswertes (D), zu einer Energie- oder Belastungskonstante (ET2, ST2) und/oder zu der Differenz eines Paars von Energie- oder Belastungskonstanten (ET1, ET2, ST1, ST2) sind.

12. Verfahren nach dem vorangehenden Anspruch, **durchdurch gekennzeichnet, dass** der Energie-Schwellwert (ET) anhand der Formel $ET = ET2 + D^2 * (ET1 - ET2)$ gewonnen wird, wobei ET der Energie-Schwellwert ist, ET1 und ET2 die Energie-Konstanten sind und D der Richtungswert ist.

13. Verfahren nach Anspruch 11 oder 12, **durchdurch gekennzeichnet, dass** der Belastungs-Schwellwert (ST) anhand der Formel $ST = ST2 + D^2 * (ST1 - ST2)$ gewonnen wird, wobei ST der Belastungs-Schwellwert ist, ST1 und ST2 die Belastungskonstanten sind und D der Richtungswert ist.

14. Verfahren nach einem der vorhergehenden Ansprüche, **durchdurch gekennzeichnet, dass** die Axialbeschleunigungs-Integralwerte (lAx, IAy) mittels eines oder mehrerer Hochpassfilter (HPF2) mit einer Grenzfrequenz zwischen 0,05 und 1 Hz gefiltert werden.

15. Verfahren nach einem der vorhergehenden Ansprüche, **durchdurch gekennzeichnet, dass** eine oder mehrere Axialbeschleunigungen (Ax, Ay, Az) aus wenigstens zwei entlang von substantiell parallelen Achsen gerichteten Axialbeschleunigungen (Ax1, Ax2, Ay1, Ay2, Az1, Az2) durch Mittelwertbildung gewonnen werden, insbesondere mit einem arithmetischen Mittelwert.

16. Verfahren nach einem der Ansprüche 2 bis 15, **durchdurch gekennzeichnet, dass** ein Unfall erkannt wird, wenn die Belastungsintensität (SI) größer ist als der Belastungs-Schwellwert (ST) und der Energiemodul (EM) größer ist als der Energie-Schwellwert (ET).

17. Verfahren nach einem der vorhergehenden Ansprüche, **durchdurch gekennzeichnet, dass** ein Unfall erkannt wird, wenn ein oder mehrere Axialbeschleunigungen (Ay1, Ay2) nach einer Wartezeit (WT) jeweils größer sind als ein Beschleunigungs-Schwellwert (AT).

18. Verfahren nach einem der vorhergehenden Ansprüche, **durchdurch gekennzeichnet, dass** die besagten Axialbeschleunigungen (Ay1, Ay2) sekundäre Axialbeschleunigungen sind.

19. Verfahren nach Anspruch 17 oder 18, **durchdurch gekennzeichnet, dass** die besagten Axialbeschleunigungen (Ay1, Ay2) mittels eines oder mehrerer Tiefpassfilter (LPF2) mit einer Grenzfrequenz zwischen 100 und 200 Hz, insbesondere zwischen 140 und 160 Hz, gefiltert wird.

20. Verfahren nach einem der Ansprüche 17 bis 19, **durchdurch gekennzeichnet, dass** ein Unfall erkannt wird, wenn auch ein Longitudinalgeschwindigkeitswert (Vx) größer ist als ein Geschwindigkeits-Schwellwert (VT).

21. Verfahren nach dem vorangehenden Anspruch, **durchdurch gekennzeichnet, dass** der Geschwindigkeits-Schwellwert (VT) zwischen 2 und 10 m/s liegt.

22. Verfahren nach Anspruch 20, **durchdurch gekennzeichnet, dass** der Longitudinalgeschwindigkeitswert (Vx) anhand der zweiten Axialbeschleunigung (Ay) und/oder der dritten Axialbeschleunigung (Az) berechnet wird.

23. Verfahren nach einem der Ansprüche 17 bis 22, **durchdurch gekennzeichnet, dass** der Beschleunigungs-Schwellwert
(AT) zwischen 0,5 und 1 g liegt.

24. Verfahren nach einem der Ansprüche 17 bis 23, **durchgekennzeichnet, dass** die Wartezeit (WT) zwischen 100 und 300 ms liegt.

25. Verfahren nach einem der vorhergehenden Ansprüche, **durchgekennzeichnet, dass** die erste Axialbeschleunigung (Ax) entlang einer ersten, zu der Hauptbewegungsrichtung des Fahrzeugs (4) substantiell parallelen Achse (x) orientiert ist, die zweite Axialbeschleunigung (Ay) entlang einer zweiten, substantiell horizontalen sowie zu der ersten Achse (x) substantiell rechtwinkligen Achse (y) orientiert ist, und/oder die dritte Axialbeschleunigung (Az) entlang einer dritten Achse (z) orientiert ist, welche substantiell rechtwinklig zu der ersten Achse (x) und der zweiten Achse (y) ist.

26. Verfahren nach einem der vorhergehenden Ansprüche, **durchgekennzeichnet, dass** das Energiemodul (EM) proportional zu der Summe der Quadrate aus den Axialbeschleunigungs-Integralwerten (lAx, lAy) ist.

27. Haupteinrichtung (1) für den Personenschutz, welche eine Hauptsteuereinheit (CU1) umfasst, die mit einem oder mehreren Hauptsensoren (9, 10) verbunden ist, um einen Aufprall eines Fahrzeugs (4) gemäß den von den Hauptsenso-rens (9, 10) gesendeten Signalen (Axyz) zu erkennen, **durchgekennzeichnet, dass** die Hauptsteuereinheit (CU1) auch mit einem oder mehreren Hilfssensoren (11, 12) verbunden ist, um ein Rutschen des Fahrzeugs (4) gemäß den von den Hilfssensoren (11, 12) gesendeten Signalen (Ax) zu erkennen, wobei die besagten Sensoren (9, 10, 11, 12) Beschleunigungssensoren auf einer oder mehreren, substantiell rechtwinklig zueinander orientierten Achsen (x, y, z) sind und Axialbeschleunigungssignale (Axyz, Ay) an die Hauptsteuereinheit CU1) senden.

28. Haupteinrichtung (1) nach dem vorangehenden Anspruch, **durchgekennzeichnet, dass** die Hauptsensoren (9, 10) geeignet sind, an einem Bereich des Fahrzeugs (4) montiert zu werden, der sich gegenüber den Sitzen für die Nutzer (7, 8) des Fahrzeugs (4) bewegen können.

29. Haupteinrichtung (1) nach Anspruch 27 oder 28, **durchgekennzeichnet, dass** die Hilfssensoren (9, 10) geeignet sind, an einem Bereich des Fahrzeugs (4) montiert zu werden, der gegenüber den Sitzen für die Nutzer (7, 8) des Fahrzeugs (4) fixiert ist.

30. Haupteinrichtung (1) nach einem der Ansprüche 27 bis 29, **durchgekennzeichnet, dass** die Hauptsteuereinheit (CU1) aus den zwei axialen Beschleunigungen (Axyz, Ay) wenigstens zwei axiale Beschleunigungen (Ax, Ay, Az) gewinnt, umfassend eine erste, entlang einer ersten Achse (x) orientierte Axialbeschleunigung (Ax) und eine zweite Axialbeschleunigung (Ay) entlang einer zweiten Achse (y), die substantiell rechtwinklig zu der ersten Achse (x) ist.

31. Haupteinrichtung (1) nach dem vorangehenden Anspruch, **durchgekennzeichnet, dass** die Beschleunigungssignale (Axyz, Ay) in einem mit der Hauptsteuereinheit (CU1) verbundenen, nichtflüchtigen Speicher (FRAM) gespeichert werden.

32. Haupteinrichtung (1) nach einem der Ansprüche 27 bis 31, **durchgekennzeichnet, dass** die Hauptsteuereinheit (CU1) auch mit einem Geschwindigkeitssensor (SS) gekoppelt ist, der an die Hauptsteuereinrichtung (CU1) Signale (Vx) über die Longitudinalgeschwindigkeit in Bezug auf das Fahrzeug (4) sendet.

33. Haupteinrichtung (1) nach einem der Ansprüche 27 bis 32, **durchgekennzeichnet, dass** die Hauptsteuereinheit (CU1) das Verfahren nach einem der Ansprüche 1 bis 26 implementiert.

34. Fahrzeug (4), **durchgekennzeichnet, dass** es eine Haupteinrichtung (1) nach einem der Ansprüche 27 bis 33 umfasst.

35. Motorrad (4), umfassend eine Vorderradgabel und einen Sattel, **durchgekennzeichnet, dass** es eine Haupt- einrichtung (1) nach einem der Ansprüche 27 bis 33 umfasst, wobei Hauptsensoren (9, 10) an der Gabel zu beiden Seiten des Vorderrades und Hilfssensoren (11, 12) unter dem Sattel montiert sind.

36. System zum Schutz einer Person, **durchgekennzeichnet, dass** es eine Haupteinrichtung (1) nach einem der Ansprüche 27 bis 33 umfasst, welche Haupteinrichtung (1) geeignet ist für die Übermittlung eines Aktivierungssignals (AS) im Fall eines Aufpralls oder Gleitens des Fahrzeugs (4) an eine oder mehrere Hilfseinrichtungen (2, 3), umfassend eine Zündsteuerung (FC) für einen oder mehrere, an einen oder mehrere Airbags (AB1, AB2) gekoppelte
Revendications

1. Procédé pour détecter des accidents, caractérisé en ce qu’il comprend les étapes opératoires suivantes :
   - l'obtention d’au moins deux accélérations axiales (Ax, Ay, Az) comprenant une première accélération axiale (Ax) orientée le long d’un premier axe (x) et une deuxième accélération axiale (Ay) orientée le long d’un deuxième axe (y) qui est sensiblement perpendiculaire au premier axe (x);
   - l'intégration d'au moins la première accélération axiale (Ax) et la deuxième accélération axiale (Ay) desdites accélérations axiales (Ax, Ay, Az) pour obtenir au moins deux valeurs d'intégrale d'accélération axiale (IAx, I Ay) ;
   - le calcul d’un module d’énergie (EM) en fonction des deux valeurs d’intégrale d’accélération axiale (IAx, I Ay) ;
   - la comparaison du module d’énergie (EM) avec un seuil d’énergie (ET).

2. Procédé selon la revendication précédente, caractérisé en ce qu’il comprend les étapes opératoires supplémentaires suivantes :
   - le calcul d’une intensité de contrainte (SI) en fonction de la première accélération axiale (Ax) et de la deuxième accélération axiale (Ay) ;
   - la comparaison de l'intensité de contrainte (SI) avec un seuil de contrainte (ST).

3. Procédé selon la revendication précédente, caractérisé en ce que l'intensité de contrainte (SI) est proportionnelle à la somme des carrés des deux accélérations axiales (Ax, Ay).

4. Procédé selon la revendication 2 ou 3, caractérisé en ce que l’intensité de contrainte (SI) est maintenue par un dispositif de maintien de crête (PH).

5. Procédé selon la revendication précédente, caractérisé en ce que le dispositif de maintien de crête (PH) est mis en œuvre de la façon suivante :

   si (SI(t)<(SI(t−1)−DCY)) alors (SI(t)=(SI(t−1)−DCY)) ;

   où SI(t) est l’intensité de contrainte et DCY est une constante de décroissance supérieure à 100 g²/ms, en particulier comprise entre 990 et 1010 g²/ms.

6. Procédé selon l’une des revendications précédentes, caractérisé en ce qu’une ou plusieurs accélérations axiales (Ax, Ay, Az) sont filtrées au moyen de filtres passe-haut (HPF1) ayant une fréquence de coupure comprise entre 0,5 et 15 Hz, en particulier entre 4 et 6 Hz.

7. Procédé selon l’une des revendications précédentes, caractérisé en ce que le seuil d’énergie (ET) et/ou le seuil de contrainte (ST) sont calculés en fonction d’une valeur de direction (D) dépendant des trois accélérations axiales (Ax, Ay, Az).

8. Procédé selon la revendication précédente, caractérisé en ce que la valeur de direction (D) est proportionnelle au carré de la troisième accélération axiale (Az) et inversement proportionnelle à la somme des carrés des trois accélérations axiales (Ax, Ay, Az).

9. Procédé selon la revendication 7 ou 8, caractérisé en ce que la valeur de direction (D) est filtrée par un filtre passe-bas (LPF1) ayant une fréquence de coupure comprise entre 1 et 100 Hz, en particulier entre 20 et 40 Hz.

10. Procédé selon l’une des revendications précédentes, caractérisé en ce que le seuil d’énergie (ET) et/ou le seuil de contrainte (ST) dépendent également d’une paire de constantes d’énergie (ET1, ET2) et/ou d’une paire de constantes de contrainte (ST1, ST2).

11. Procédé selon la revendication précédente, caractérisé en ce que le seuil d’énergie (ET) et/ou le seuil de contrainte
(ST) sont proportionnels au carré de la valeur de direction (D), à une constante d’énergie ou de contrainte (ET2, ST2) et/ou à la différence de la paire de constantes d’énergie ou de contrainte (ET1, ET2, ST1, ST2).

12. Procédé selon la revendication précédente, caractérisé en ce que le seuil d’énergie (ET) est obtenu au moyen de la formule $ET = ET_2 + D^2(ET_1 - ET_2)$, où ET est le seuil d’énergie, ET1 et ET2 sont les constantes d’énergie et D est la valeur de direction.

13. Procédé selon la revendication 11 ou 12, caractérisé en ce que le seuil de contrainte (ST) est obtenu au moyen de la formule $ST = ST_2 + D^2(ST_1 - ST_2)$, où ST est le seuil de contrainte, ST1 et ST2 sont les constantes de contrainte et D est la valeur de direction.

14. Procédé selon l’une des revendications précédentes, caractérisé en ce que les valeurs entières d’accélération axiale (IAx, IAy) sont filtrées par un ou plusieurs filtres passe-haut (HPF2) ayant une fréquence de coupure comprise entre 0,05 et 1 Hz.

15. Procédé selon l’une des revendications précédentes, caractérisé en ce qu’une ou plusieurs des accélération axiales (Ax, Ay, Az) sont obtenues avec une moyenne, en particulier une moyenne arithmétique, d’au moins deux accélérations axiales (Ax1, Ax2, Ay1, Ay2, Az1, Az2) orientées le long d’axes sensiblement parallèles.

16. Procédé selon l’une des revendications 2 à 15, caractérisé en ce qu’un accident est détecté si l’intensité de contrainte (SI) est supérieure au seuil de contrainte (ST) et le module d’énergie (EM) est supérieur au seuil d’énergie (ET).

17. Procédé selon l’une des revendications précédentes, caractérisé en ce qu’un accident est détecté si un ou plusieurs accélérations axiales (Ay1, Ay2) après un temps d’attente (WT) sont toujours supérieures à un seuil d’accélération (AT).

18. Procédé selon l’une des revendications précédentes, caractérisé en ce que lesdites accélérations axiales (Ay1, Ay2) sont des deuxièmes accélérations axiales.

19. Procédé selon la revendication 17 ou 18, caractérisé en ce que lesdites accélérations axiales (Ay1, Ay2) sont filtrées par un ou plusieurs filtres passe-bas (LPF2) ayant une fréquence de coupure comprise entre 100 et 200 Hz, en particulier entre 140 et 160 Hz.

20. Procédé selon l’une des revendications 17 à 19, caractérisé en ce qu’un accident est détecté si également une valeur de vitesse longitudinale (Vx) est supérieure à un seuil de vitesse (VT).

21. Procédé selon la revendication précédente, caractérisé en ce que le seuil de vitesse (VT) est compris entre 2 et 10 m/s.

22. Procédé selon la revendication 20, caractérisé en ce que la valeur de vitesse longitudinale (Vx) est calculée en fonction de la deuxième accélération axiale (Ay) et/ou de la troisième accélération axiale (Az).

23. Procédé selon l’une des revendications 17 à 22, caractérisé en ce que le seuil d’accélération (AT) est compris entre 0,5 et 1 g.

24. Procédé selon l’une des revendications 17 à 23, caractérisé en ce que le temps d’attente (WT) est compris entre 100 et 300 ms.

25. Procédé selon l’une des revendications précédentes, caractérisé en ce que la première accélération axiale (Ax) est orientée le long d’un premier axe (x) sensiblement parallèle à la direction de déplacement principale d’un véhicule (4), la deuxième accélération axiale (Ay) est orientée le long d’un deuxième axe (y) sensiblement horizontal et sensiblement perpendiculaire au premier axe (x), et/ou la troisième accélération axiale (Az) est orientée le long d’un troisième axe (z) sensiblement perpendiculaire au premier axe (x) et au deuxième axe (y).

26. Procédé selon l’une des revendications précédentes, caractérisé en ce que le module d’énergie (EM) est proportionnel à la somme des carrés des valeurs d’intégrale d’accélération axiale (IAx, IAy).
27. Appareil principal (1) pour la protection individuelle, qui comprend une unité de commande principale (CU1) qui est connectée à un ou plusieurs capteurs principaux (9, 10) pour détecter un impact d’un véhicule (4) en fonction de signaux (Axyz) envoyés par les capteurs principaux (9, 10), caractérisé en ce que l’unité de commande principale (CU1) est également connectée à un ou plusieurs capteurs auxiliaires (11, 12) pour détecter un glissement du véhicule (4) en fonction de signaux (Ay) envoyés par les capteurs auxiliaires (11, 12), dans lequel lesdits capteurs (9, 10, 11, 12) sont des capteurs d’accélération sur un ou plusieurs axes (x, y, z) sensiblement perpendiculaires les uns aux autres et envoient des signaux d’accélération axiale (Axyz, Ay) à l’unité de commande principale (CU1).

28. Appareil principal (1) selon la revendication précédente, caractérisé en ce que les capteurs principaux (9, 10) sont appropriés pour être montés sur une partie d’un véhicule (4) qui peut se déplacer par rapport aux sièges pour les utilisateurs (7, 8) du véhicule (4).

29. Appareil principal (1) selon la revendication 27 ou 28, caractérisé en ce que les capteurs auxiliaires (11, 12) sont appropriés pour être montés sur une partie d’un véhicule (4) qui est fixe par rapport aux sièges pour les utilisateurs (7, 8) du véhicule (4).

30. Appareil principal (1) selon l’une des revendications 27 à 29, caractérisé en ce qu’à partir desdits signaux d’accélération axiale (Axyz, Ay), l’unité de commande principale (CU1) obtient au moins deux accélérations axiales (Ax, Ay, Az) comprenant une première accélération axiale (Ax) orientée le long d’un premier axe (x) et une deuxième accélération axiale (Ay) orientée le long d’un deuxième axe (y) qui est sensiblement perpendiculaire au premier axe (x).

31. Appareil principal (1) selon la revendication précédente, caractérisé en ce que les signaux d’accélération (Axyz, Ay) sont stockés dans une mémoire non volatile (FRAM) connectée à l’unité de commande principale (CU1).

32. Appareil principal (1) selon l’une des revendications 27 à 31, caractérisé en ce que l’unité de commande principale (CU1) est également connectée à un capteur de vitesse (SS) qui envoie à l’unité de commande principale (CU1) des signaux de vitesse longitudinale (Vx) relatifs au véhicule (4).

33. Appareil principal (1) selon l’une des revendications 27 à 32, caractérisé en ce que l’unité de commande principale (CU1) met en œuvre le procédé selon l’une des revendications 1 à 26.

34. Véhicule (4), caractérisé en ce qu’il comprend un appareil principal (1) selon l’une des revendications 27 à 33.

35. Motocyclette (4) comprenant une fourche de la roue avant et une selle, caractérisée en ce qu’elle comprend un appareil principal (1) selon l’une des revendications 27 à 33, où les capteurs principaux (9, 10) sont montés sur la fourche des deux côtés de la roue avant et les capteurs secondaires (11, 12) sont montés sous la selle.

36. Système pour la protection individuelle, caractérisé en ce qu’il comprend un appareil principal (1) selon l’une quelconque des revendications 27 à 33, lequel appareil principal (1) est approprié pour transmettre un signal d’activation (AS) en cas d’impact ou de glissement d’un véhicule (4) à un ou plusieurs appareils secondaires (2, 3) comprenant un dispositif de commande de mise à feu (FC) connecté à un ou plusieurs générateurs de gaz (GG1, GG2) connectés à un ou plusieurs coussins gonflables (AB1, AB2).
Fig. 3

Fig. 4
Fig. 5
Fig. 6
Fig. 8
Fig. 10
REFERENCES CITED IN THE DESCRIPTION

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