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(54) Title: VEHICULAR ANGLE ALERT AND SAFETY SYSTEM AND METHOD

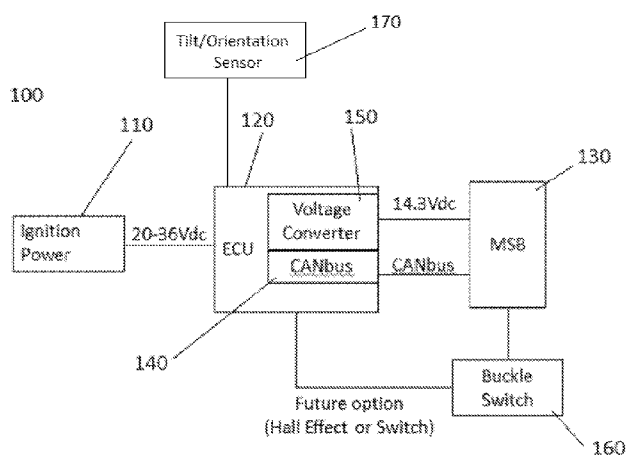


FIG. 1

(57) Abstract: The invention consists of various embodiments of a system that uses electromechanical means to alert a vehicle operator of an imminent vehicle roll-over and protect the operator in a roll-over event. The system uses an electronics control unit (ECU) that is able to detect the deflection angle of the vehicle's tilt with the horizontal. If this angle exceeds a certain amount, the operator is alerted of the increased risk of roll-over via haptic feedback whereby the ECU controls a seatbelt electromechanical system to create a haptic feedback alert to the operator. If the angle exceeds a second higher amount, the system braces the operator for a roll-over event by tightening the seatbelt, thereby better protecting the operator. The fact that the system is electromechanical, instead of pyrotechnical, makes the system reusable.

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— *with international search report (Art. 21(3))*

1 VEHICULAR ANGLE ALERT AND SAFETY SYSTEM AND METHOD

2
3 CROSS-REFERENCE TO RELATED APPLICATIONS

4 **[0001]** This Non-Provisional Patent Application claims the benefit of the currently
5 pending U.S. Provisional Patent Application No. 62/207,698, filed on August 20, 2015,
6 and is incorporated by reference as if fully set forth herein.

7
8 FIELD OF THE INVENTION

9 **[0002]** This invention relates generally to the field of vehicle safety, and more
10 particularly, to a vehicular angle alert and safety system and integrated method.

11
12 BACKGROUND

13 **[0003]** Roll-over accidents cause a substantial number of injuries and deaths every
14 year. Particularly in utility and work vehicles that are used in dangerous locations, the
15 risk of rolling-over the vehicle adds to the already heightened level of risk for work-
16 related injury. Examples of such danger-prone vehicles are the various mining vehicles
17 that are often operated in open mines where they have to navigate tight, unpaved roads
18 up and down the sides of the open mine. The bulky and heavy design of these vehicles
19 makes their operation relatively dangerous, especially on such narrow and unpaved
20 passages. Furthermore, the center of gravity of many of these vehicles is very high due to
21 the manner with which they transport their payload, thus increasing the risk of a
22 vehicular roll-over. In order to avoid such accidents, operators are trained to look out for
23 terrain risks while conducting their driving duties; however, this practice sometimes falls
24 short due to human error and terrain risks that are not obvious to the operator.

25 **[0004]** Some safety solutions have been utilized to alert the operator or to protect the
26 operator during the roll-over. Some systems, as may be known in the art, utilize a
27 pyrotechnic, triggered and mechanically placed, so that it tightens and locks the
28 operator's seatbelt upon detection of a roll-over. These systems, however, are reactive to
29 the incident. As such, they help to prevent injury to the operator in a roll-over event, but
30 they do not operate in such a way as to prevent the event from occurring in the first place.
31 Furthermore, due to the exhaustive nature of the pyrotechnics utilized in these types of
32 safety systems, the systems can only be used once and must be replaced after use.

1 **[0005]** It would therefore be desirable to have a reusable safety system that is
2 integrated with the seatbelt of the operator so that the safety system is able to both alert
3 the operator of an unsafe vehicle angular orientation and better protect the operator in
4 the event of a roll-over.

5 **[0006]** It would also be desirable to have an integrated method with which the
6 reusable safety system operates in order to assist the operator in preventing roll-overs
7 while remaining ready to protect the operator in the event of a roll-over.

8 **[0007]** While certain aspects of conventional technologies have been discussed to
9 facilitate disclosure of the invention, Applicant in no way disclaims these technical
10 aspects, and it is contemplated that the claimed invention may encompass one or more
11 of the conventional technical aspects discussed herein.

12 **[0008]** In this specification where a document, act, or item of knowledge is referred to
13 or discussed, this reference or discussion is not an admission that the document, act, or
14 item of knowledge or any combination thereof was at the priority date, publicly available,
15 known to the public, part of common general knowledge, or otherwise constitutes prior
16 art under the applicable statutory provisions; or is known to be relevant to an attempt to
17 solve any problem with which this specification is concerned.

18 19 SUMMARY

20 **[0009]** The present invention is directed to a roll-over avoidance system and
21 integrated method for vehicles that alerts the driver or operator as the vehicle's risk of
22 rolling-over increases and protects the operator upon the event of such a roll-over.

23 **[0010]** With respect to the system, embodiments thereof provide for a roll-over
24 avoidance and protection system comprising the following components: a tilt or
25 orientation sensor capable of detecting angle of orientation, an electronic control unit
26 (ECU), a power source, and an electromechanical system, operatively coupled to the
27 operator's seatbelt. The tilt or orientation sensor, power source, and electromechanical
28 system are all electrically connected to the ECU.

29 **[0011]** Embodiments of the ECU are configured to receive tilt/angle measurements
30 from the tilt and/or orientation sensor, which is operatively coupled to the vehicle. When
31 the vehicle tilts beyond a first critical angle (a certain set angle with respect to the vertical
32 or horizontal), the tilt and/or orientation sensor detects this event and communicates it

1 to the ECU. Upon receiving notice of the first critical angle, the ECU alerts the driver or
2 operator by the use of a haptic feedback means. Preferred embodiments of said haptic
3 feedback means include sequential tugging of the operator's seatbelt, by
4 electromechanical means, in order to alert the operator of the dangerous angle of the
5 vehicle and increased risk of rolling over.

6 **[0012]** The haptic feedback means continues until the vehicle's orientation is returned
7 to an angle below the first critical angle or until the vehicle's angle reaches a second
8 critical angle, which exceeds the first critical angle. The second critical angle is calculated
9 to be the angle by which the vehicle is in danger of rolling over or in the process of rolling
10 over. If the system detects the second critical angle, the operator's seatbelt automatically
11 tightens, and remains tight, by electromechanical means.

12 **[0013]** Other embodiments of the ECU may further comprise additional means to
13 determine orientation and calculate tilt/angle measurements so as to remove the need
14 for a separate or external orientation sensor.

15 **[0014]** Other embodiments of the system may further comprise a buckle switch that
16 may be utilized in order to activate or deactivate the system when the operator is
17 fastened to the seat or when the operator is not, respectively.

18 **[0015]** Embodiments of the present invention may also comprise an integrated
19 method of operation whereby during the operation of the vehicle, the system is
20 concurrently detecting the angle of orientation of the vehicle with respect to the
21 horizontal or vertical. Once the vehicle's orientation is detected to exceed a certain first
22 critical angle, in any direction, the system will alert the operator with the use of a haptic
23 feedback means. The haptic feedback would serve as a warning, thus giving the operator
24 a chance to correct the vehicle and return it to a safe, level-orientation. However, if the
25 system detects that the vehicle's orientation exceeds said first critical angle and further
26 exceeds the second critical angle, wherein said second critical angle is higher than the
27 first critical angle, the system will brace the operator for a roll-over event by tightening
28 the seatbelt. In this embodiment, the system is, therefore, continuously measuring the tilt
29 angle of the vehicle in order to provide the proper response for the given vehicle tilt angle.

30 **[0016]** Certain embodiments of the present invention may be used for, but not limited
31 to, vehicle safety beyond mining applications, such as vehicles in commercial, military,
32 police, ambulatory, off-roading, sports, and recreational applications.

1 **[0017]** Other embodiments of the present invention may be used for, but not limited
2 to, vehicle safety beyond road-based vehicles, such as boats or other forms of watercraft.

3 **[0018]** The present invention may address one or more of the problems and
4 deficiencies of the prior art discussed above. However, it is contemplated that the
5 invention may prove useful in addressing other problems and deficiencies in a number of
6 technical areas. Therefore the claimed invention should not necessarily be construed as
7 limited to addressing any of the particular problems or deficiencies discussed herein.

8 9 BRIEF DESCRIPTION OF THE DRAWINGS

10 **[0019]** These and other features, aspects, and advantages of the present invention will
11 become better understood with regard to the following description, appended claims,
12 and accompanying drawings where:

13 **[0020]** FIG. 1 is a system diagram in accordance with an embodiment of the present
14 invention showing a vehicle angle alert and safety system;

15 **[0021]** FIG. 2 is a system diagram in accordance with another embodiment of the
16 present invention showing a vehicle angle alert and safety system; and

17 **[0022]** FIG. 3 is a process flowchart in accordance with another embodiment of the
18 present invention showing a vehicle angle alert and safety process.

19 20 DESCRIPTION

21 **[0023]** In the Summary above, in the Description and appended Claims below, and in
22 the accompanying drawings, reference is made to particular features of the invention. It
23 is to be understood that the disclosure of the invention in this specification includes all
24 possible combinations of such particular features. For example, where a particular
25 feature is disclosed in the context of a particular aspect or embodiment of the invention,
26 or a particular claim, that feature can also be used, to the extent possible, in combination
27 with and/or in the context of other particular aspects and embodiments of the invention,
28 and in the invention generally.

29 **[0024]** The term “comprises” and grammatical equivalents thereof are used herein to
30 mean that other components, structures, steps, etc. are optionally present. For example,
31 an article “comprising” (or “which comprises”) components A, B, and C can consist of (i.e.,
32 contain only) components A, B, and C, or can contain not only components A, B, and C but

1 also one or more other components or structures.

2 **[0025]** The term “at least” followed by a number is used herein to denote the start of
3 a range beginning with that number (which may be a range having an upper limit or no
4 upper limit, depending on the variable being defined). For example “at least 1” means 1
5 or more than 1. The term “at most” followed by a number is used herein to denote the
6 end of a range ending with that number (which may be a range having 1 or 0 as its lower
7 limit, or a range having no lower limit, depending upon the variable being defined). For
8 example, “at most 4” means 4 or less than 4, and “at most 40%” means 40% or less than
9 40%. When, in this specification, a range is given as “(a first number) to (a second
10 number)” or “(a first number)-(a second number),” this means a range whose lower limit
11 is the first number and whose upper limit is the second number. For example, 25 to 100
12 mm means a range whose lower limit is 25 mm, and whose upper limit is 100 mm.

13 **[0026]** The term “electromechanical system” is synonymous with the term “motorized
14 seatbelt” or “MSB” and refers to a system that comprises at least one electromechanical
15 component and a seatbelt.

16 **[0027]** While this specification concludes with claims defining the features of
17 embodiments of the invention that are regarded as novel, it is believed that the invention
18 will be better understood from a consideration of the following description in conjunction
19 with the figures, in which like reference numerals are carried forward.

20 **[0028]** Referring to FIGs. 1 and 2, an embodiment of the present invention is a roll-
21 over warning and safety system 100, which is made up of the following components: a tilt
22 or orientation sensor 170 capable of detecting angle of orientation, an electronic control
23 unit (ECU) 120, a power source 110, and an electromechanical system 130, which is
24 operatively coupled to the operator’s seatbelt. The components relate to each other as
25 follows: the orientation sensor 170, power source 110, and electromechanical system
26 130 are all electrically connected to the ECU 120 so as to receive power, receive
27 environmental inputs, output signals, etc.

28 **[0029]** In the embodiment shown in FIG. 1, the ECU 120 is electrically connected to
29 the vehicle’s electrical system. This electrical system acts as the power source 110 for the
30 ECU 120 and, via the ECU 120, powers the other components of the system 100. One
31 skilled in the art, however, will appreciate that the power source 110 can be
32 accomplished using a variety of power source means, such power source means may

1 include, but not limited to, a separate power source isolated from the vehicle's electrical
2 system, a portable power source, or other means of delivering electrical power to the
3 system. Furthermore, depending on the voltage with which the ECU 120 functions, a
4 voltage converter 150 may be needed in order to convert the voltage output from the
5 electrical system or power source 110 to a voltage level that is within the acceptable
6 range of the ECU 120. The voltage converter 150 may be integrated in the ECU 120 as in
7 system 100 in FIG.1 or separate from the ECU 120 as in system 200 in FIG.2. The
8 orientation sensor 170 is fixed to the vehicle in such a manner so as to effectively read
9 the vehicle's tilt orientation or angular deflection from the horizontal. The orientation
10 sensor 170 may be in the form of a means that includes, but is not limited to, the use of:
11 gyroscopes, Hall voltage sensors, rotary variable differential transformers, piezo-electric
12 transducers, potentiometers, rotary encoders, string potentiometers, or fluid level
13 measurement. The ECU 120 receives data regarding the tilt or angular deflection from the
14 orientation sensor 170 and compares this data to a pre-programmed, or user-set, first
15 critical angle and second critical angle. Depending on the angle measurement in relation
16 to the first critical and second critical angles, the ECU 120 will either send a command to
17 the electromechanical system 130 or refrain from doing so. It is contemplated that the
18 orientation sensor 170 and ECU 120 can be capable of detecting and processing any
19 number of critical angles and sending a prescribed command to the electromechanical
20 system 130 for the instance that those angles are detected. The communication between
21 the ECU 120 and the electromechanical system 130 may be done by various means, but
22 is preferably by means of a CANbus 140 (Controller Area Network bus) connection. Other
23 anticipated means of communication between such system components may include, but
24 are not limited to, conventional electrical wiring, fiber optics, wireless communication, or
25 other means known in the art. In one embodiment, the electromechanical system 130 is
26 in the form of an electromotor that is physically connected to the operator's seatbelt in
27 such a manner as to allow for the electromotor to loosen or tighten the seatbelt. The
28 electromotor can be of a variety of electromechanical devices such as, but not limited to,
29 a stepping motor, servo, electrically-controlled pneumatics, electrically-controlled
30 hydraulics, or any other conventional method of creating a physical response with an
31 electronic command.

32 **[0030]** Alternate embodiments of the system include a system where the tilt or

1 orientation sensor 170 is incorporated in the hardware of the ECU 120. In such a case, the
2 orientation sensor 170 will not be a separate component of the system, but will rather be
3 replaced by a functional capability of the ECU 120 thus eliminating the need for
4 installation of the separate component, as is shown in FIGs 1 and 2. It should be noted,
5 however, that if the ECU 120 is to detect angle deflection, it will necessitate installment
6 onto the vehicle in a manner that accurate readings of the vehicle's tilt or angular
7 orientation may be taken.

8 **[0031]** Embodiments may also further comprise a buckle switch 160 that may be in
9 the form of a seatbelt latch whereby the operator's action of buckling his seatbelt
10 completes the electrical connection between the ECU 120 and the electromechanical
11 system 130. Completing the electrical connection between the ECU 120 and the
12 electromechanical system 130 activates the electromechanical system 130 so that the
13 operator may automatically engage the vehicular angle alert and safety system 100 when
14 the seatbelt is in use and disengage the system when the seatbelt is not in use.
15 Alternatively, the buckle switch 160 may just have a digital input 220 which
16 communicates to the ECU 120 whether the operator is fastened to the seatbelt so that the
17 ECU 120 may activate the electromechanical system 130.

18 **[0032]** A further embodiment of the present invention is in the form of a method 300
19 utilized by the ECU 120 in detecting critical angles, alerting the operator, and bracing the
20 operator in the case of a roll-over event. The method 300 comprises the following steps:
21 monitoring tilt angle of vehicle 310; detecting a tilt angle at or above a first critical angle
22 330; and outputting a first electrical command to an electrical motor 360, wherein said
23 first command prompts said electrical motor to tighten and loosen a seatbelt in a
24 sequential manner. This sequential tightening and loosening is commonly referred to as
25 haptic-feedback and is meant to alert the operator of risk of a dangerous event, which in
26 this case is a vehicle roll-over. The ECU then continuously monitors the tilt angle of the
27 vehicle 310 for changes in angle. This haptic feedback will continue for the duration that
28 the vehicle remains in this angular orientation.

29 **[0033]** If the operator adjusts the vehicle's tilt to a safe position, below the first critical
30 angle, the following steps are performed: monitoring tilt angle of vehicle 310; detecting a
31 second orientation angle below said first critical angle 320; and stopping said output of
32 said first electrical command 350. By stopping the output of the first electrical command,

1 the haptic feedback is effectively stopped. The ECU then continuously monitors the tilt
2 angle of the vehicle 310 for changes in angle.

3 **[0034]** However, if the tilt or deflection from the horizontal increases to a dangerous
4 level, at or beyond a second critical angle, the following steps are performed: monitoring
5 tilt angle of vehicle 310; detecting a second orientation angle at or above a second critical
6 angle 340; and outputting a second electrical command to said electric motor 370,
7 wherein said second electrical command prompts said electric motor to tighten said
8 seatbelt into a locked position. The ECU then continuously monitors the tilt angle of the
9 vehicle 310 for changes in angle.

10 **[0035]** If the operator is able to return the vehicle to a tilt angle below the second
11 critical angle, the ECU 120 performs the following steps: monitoring tilt angle of vehicle
12 310; detecting a third orientation angle below said second critical angle and at or above
13 said first critical angle 330; and outputting said first electrical command to said electrical
14 motor 360. This will return the system's response from bracing the operator for a roll-
15 over to the haptic feedback alert. The ECU then continuously monitors the tilt angle of the
16 vehicle 310 for changes in angle.

17 **[0036]** If the operator returns the vehicle's tilt to a safe position, below the first critical
18 angle, the following steps are performed: monitoring tilt angle of vehicle 310; detecting
19 a fourth orientation angle below said first critical angle 320; and stopping said output of
20 said first electrical command 350. This would stop the output of the first electrical
21 command, thus stopping the haptic feedback.

22 **[0037]** In light of the foregoing description, it should be recognized that embodiments
23 in accordance with the present invention can be realized in numerous configurations
24 contemplated to be within the scope and spirit of the claims. Additionally, the description
25 above is intended by way of example only and is not intended to limit the present
26 invention in any way, except as set forth in the claims.

27

CLAIMS

What is claimed is:

1. A vehicle safety system, the system comprising:
 - a means for detecting angle of orientation;
 - an electronic control unit (ECU), electrically connected to said means for detecting angle of orientation;
 - a power source, electrically connected to said ECU;
 - an electric motor, electrically connected to said ECU; and
 - a seatbelt, mechanically fixed to said electric motor.
2. The vehicle safety system of claim 1, further comprising a buckle switch, wherein said buckle switch is mechanically fixed to said seatbelt and electrically connected to said ECU.
3. The vehicle safety system of claim 1, further comprising a voltage converter, electrically connected between said ECU and said electric motor.
4. A vehicle safety system, the system comprising:
 - an electronic control unit (ECU), said ECU capable of angle orientation with respect to horizontal;
 - a power source, electrically connected to said ECU;
 - an electric motor, electrically connected to said ECU; and
 - a seatbelt, mechanically fixed to said electric motor.
5. The vehicle safety system of claim 4, further comprising a buckle switch, wherein said buckle switch is mechanically fixed to said seatbelt and electrically connected to said ECU.
6. The vehicle safety system of claim 4, further comprising a voltage converter, electrically connected between said ECU and said electric motor.
7. A method for vehicle roll-over safety protocol, the steps of which comprising:
 - detecting an orientation angle at or above a first critical angle; and
 - outputting a first electrical command to an electrical motor, wherein said first command prompts said electrical motor to tighten and loosen a seatbelt in a sequential manner.
8. The method of claim 7, further comprising the steps of:

1 detecting a second orientation angle below said first critical angle; and
2 stopping said output of said first electrical command.

3 9. The method of claim 7, further comprising the steps of:

4 detecting a second orientation angle at or above a second critical angle;
5 stopping said output of said first electrical command; and
6 outputting a second electrical command to said electric motor, wherein said
7 second electrical command prompts said electric motor to tighten said
8 seatbelt into a locked position.

9 10. The method of claim 9, further comprising the steps of:

10 detecting a third orientation angle below said second critical angle and at or above
11 said first critical angle;
12 stopping said output of said second electrical command; and
13 outputting said first electrical command to said electrical motor.

14 11. The method of claim 10, further comprising the steps of:

15 detecting a fourth orientation angle below said first critical angle; and
16 stopping said output of said first electrical command.

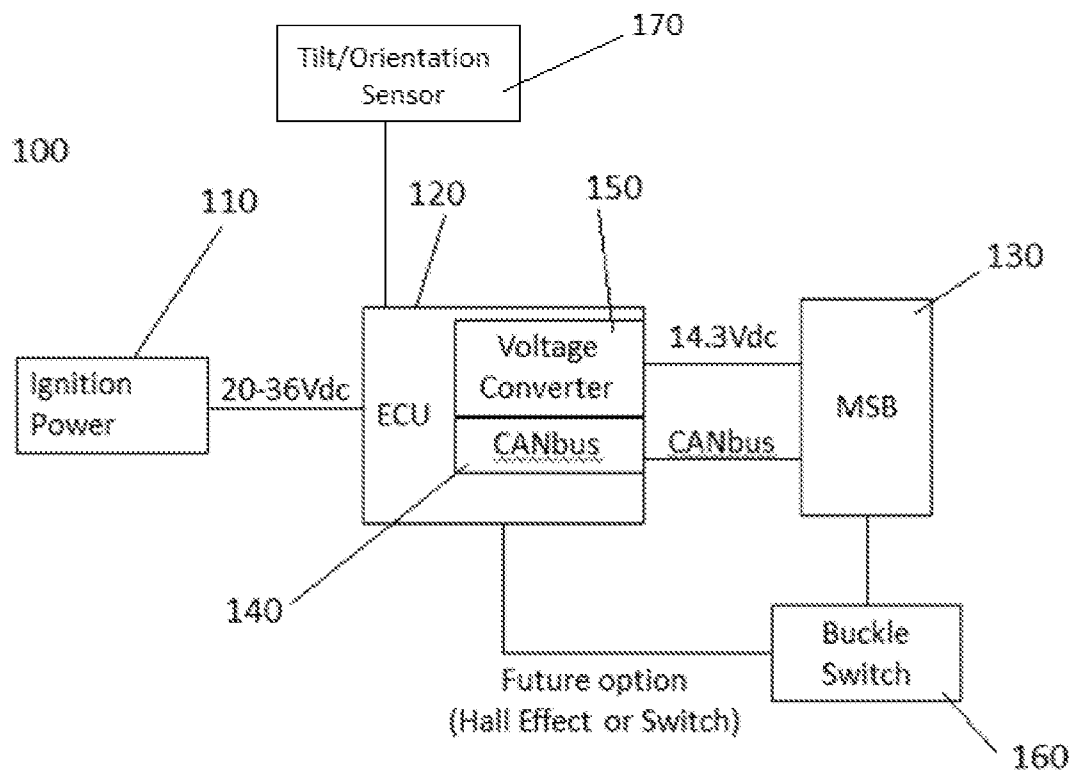


FIG. 1

200

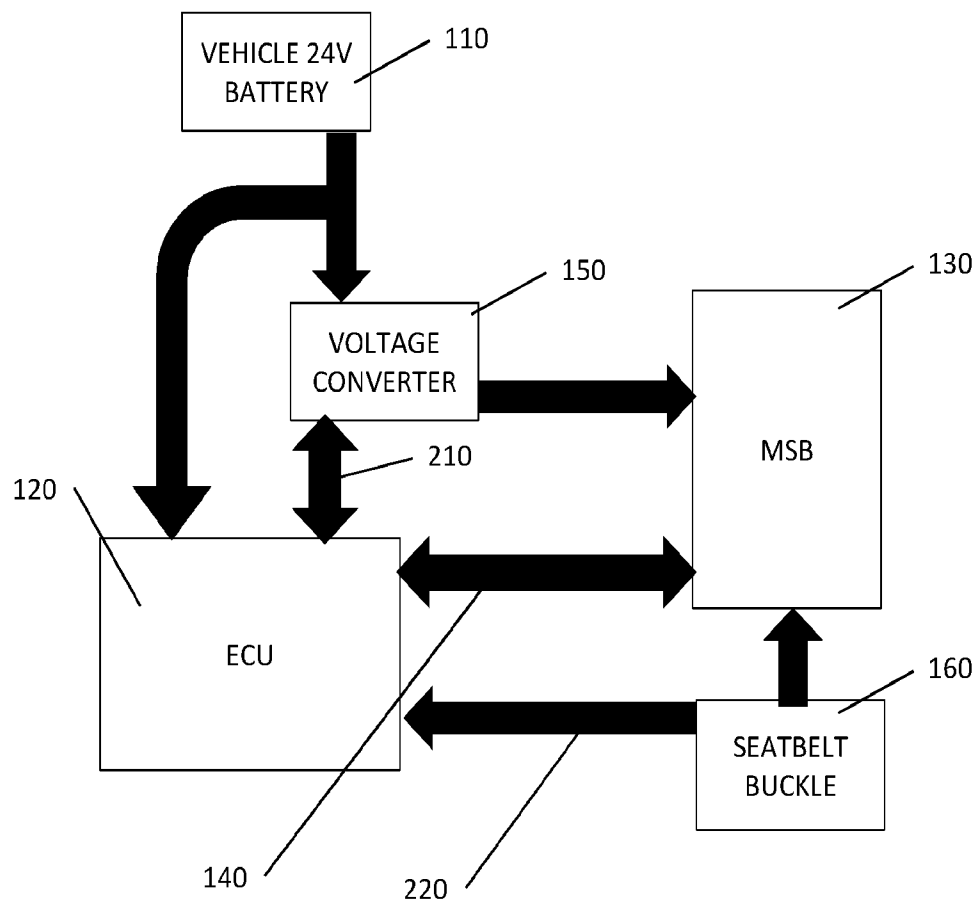


FIG. 2

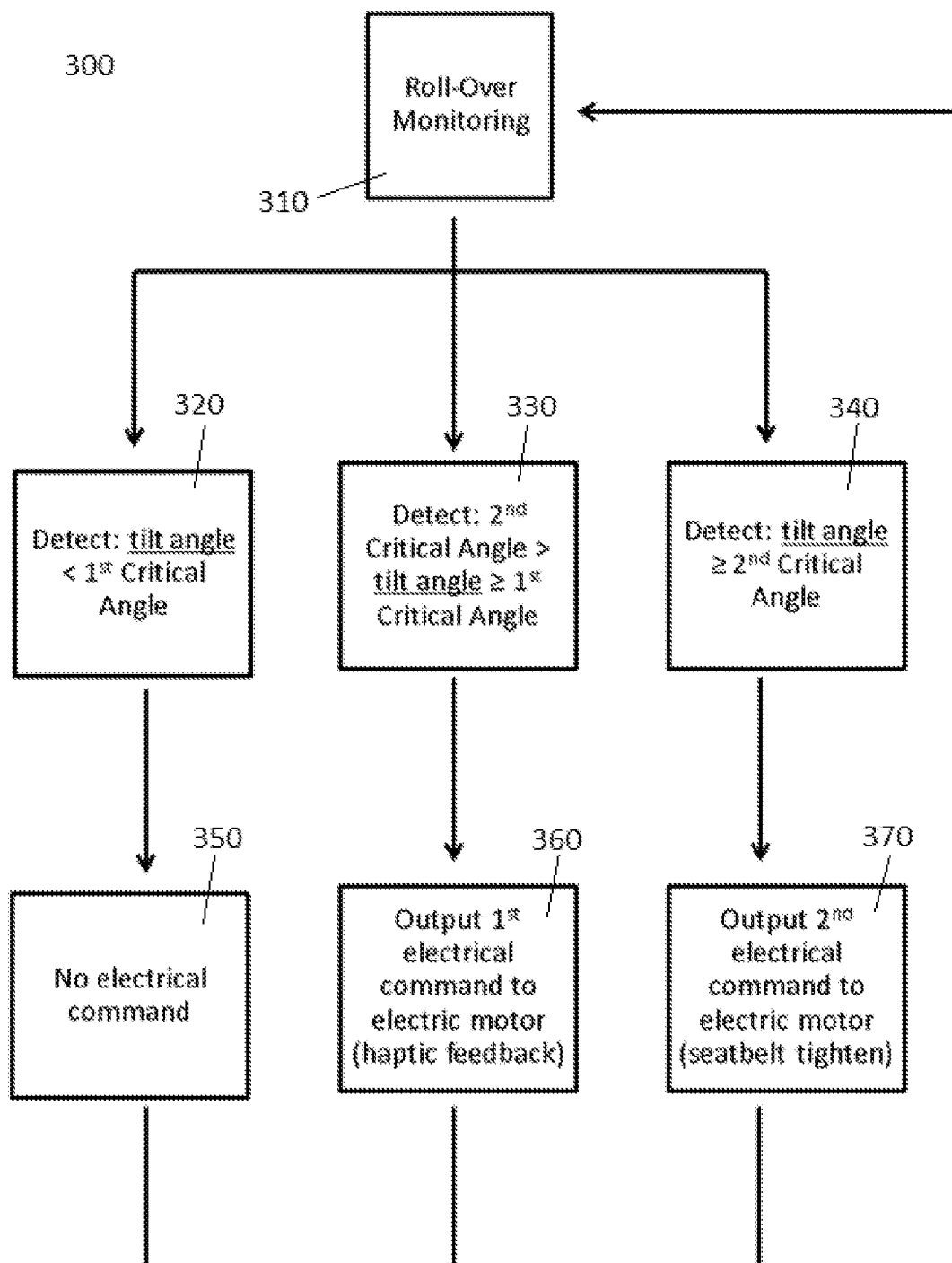


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US16/47795

A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - B60R 22/04, 22/48; G08B 21/02, 21/24 (2016.01) CPC - B60R 22/04, 22/48; G08B 21/02, 21/24 According to International Patent Classification (IPC) or to both national classification and IPC																				
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC(8) Classifications: B60R 22/04, 22/48; G08B 21/02, 21/24 (2016.01) CPC Classifications: B60R 22/04, 22/48, 2022/4808; G08B 21/02, 21/24 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, Other Countries, (INPADOC), RU, AT, CH, TH, BR, PH); Google, IEEE, EBSCO; Keywords: seat_belt, retractor, angle, critical, electronic, control, unit, ECU, motor, electrical, detect*, voltage, converter, power, buckle, switch, safety, belt, passenger, twist, detect*, second, roll, over, vehicle																				
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X --- Y</td> <td>US 2007/0284868 A1 (ODATE, S) December 13, 2007; abstract, figures 1, 2, & 6, paragraphs [0026], [0027], [0029], [0034], & [0041], claim 1</td> <td>1, 2, 4, 5 ---- 3, 6</td> </tr> <tr> <td>Y</td> <td>US 2013/0249451 A1 (KOBAYASHI, M) September 26, 2013; figure 1, paragraph [0036]</td> <td>3, 6</td> </tr> <tr> <td>Y</td> <td>US 8,086,376 B2 (MCCOY, R et al.) December 27, 2011; figure 4; column 8, lines 29-35; column 9, lines 17-34</td> <td>7, 8</td> </tr> <tr> <td>Y</td> <td>US 7,681,949 B2 (NATHAN, J et al.) March 23, 2010; column 2, lines 41-47; column 4, lines 41-48</td> <td>7, 8</td> </tr> <tr> <td>A</td> <td>US 2008/0300753 A1 (BAUER, K et al.) December 4, 2008; paragraphs [0038], [0044], [0048], & [0049]</td> <td>1-11</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X --- Y	US 2007/0284868 A1 (ODATE, S) December 13, 2007; abstract, figures 1, 2, & 6, paragraphs [0026], [0027], [0029], [0034], & [0041], claim 1	1, 2, 4, 5 ---- 3, 6	Y	US 2013/0249451 A1 (KOBAYASHI, M) September 26, 2013; figure 1, paragraph [0036]	3, 6	Y	US 8,086,376 B2 (MCCOY, R et al.) December 27, 2011; figure 4; column 8, lines 29-35; column 9, lines 17-34	7, 8	Y	US 7,681,949 B2 (NATHAN, J et al.) March 23, 2010; column 2, lines 41-47; column 4, lines 41-48	7, 8	A	US 2008/0300753 A1 (BAUER, K et al.) December 4, 2008; paragraphs [0038], [0044], [0048], & [0049]	1-11
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A	US 2008/0300753 A1 (BAUER, K et al.) December 4, 2008; paragraphs [0038], [0044], [0048], & [0049]	1-11																		
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.																				
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