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(54) **OCCUPANT SENSING SYSTEM FOR A VEHICLE**

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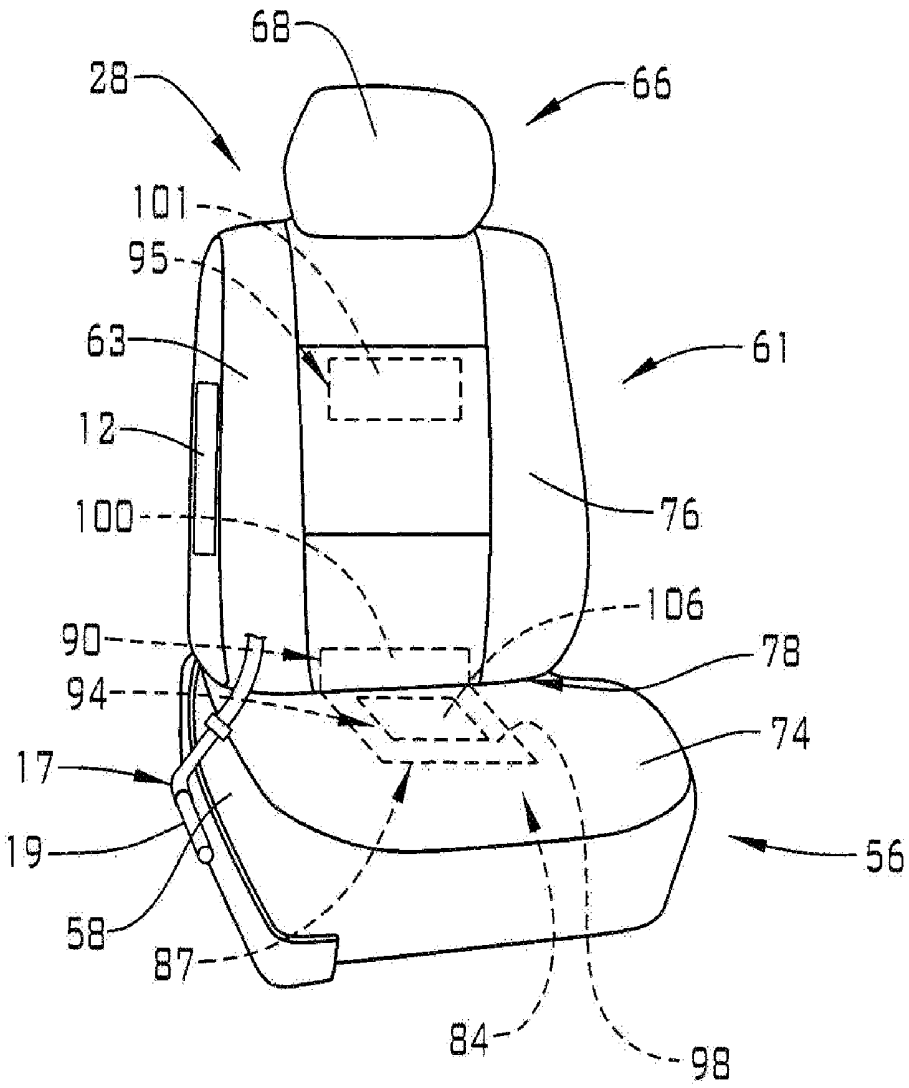
(57) **ABSTRACT**

An occupant detection system includes a vehicle seat having a seat back and a seat base, and a biometric sensor arranged in at least one of the seat back and the seat base. The biometric sensor is configured to detect a physiological characteristic of a seat occupant. A controller is operatively connected to the biometric sensor. The controller is configured to provide an output signal in response to a physiological characteristic detected signal from the biometric sensor.



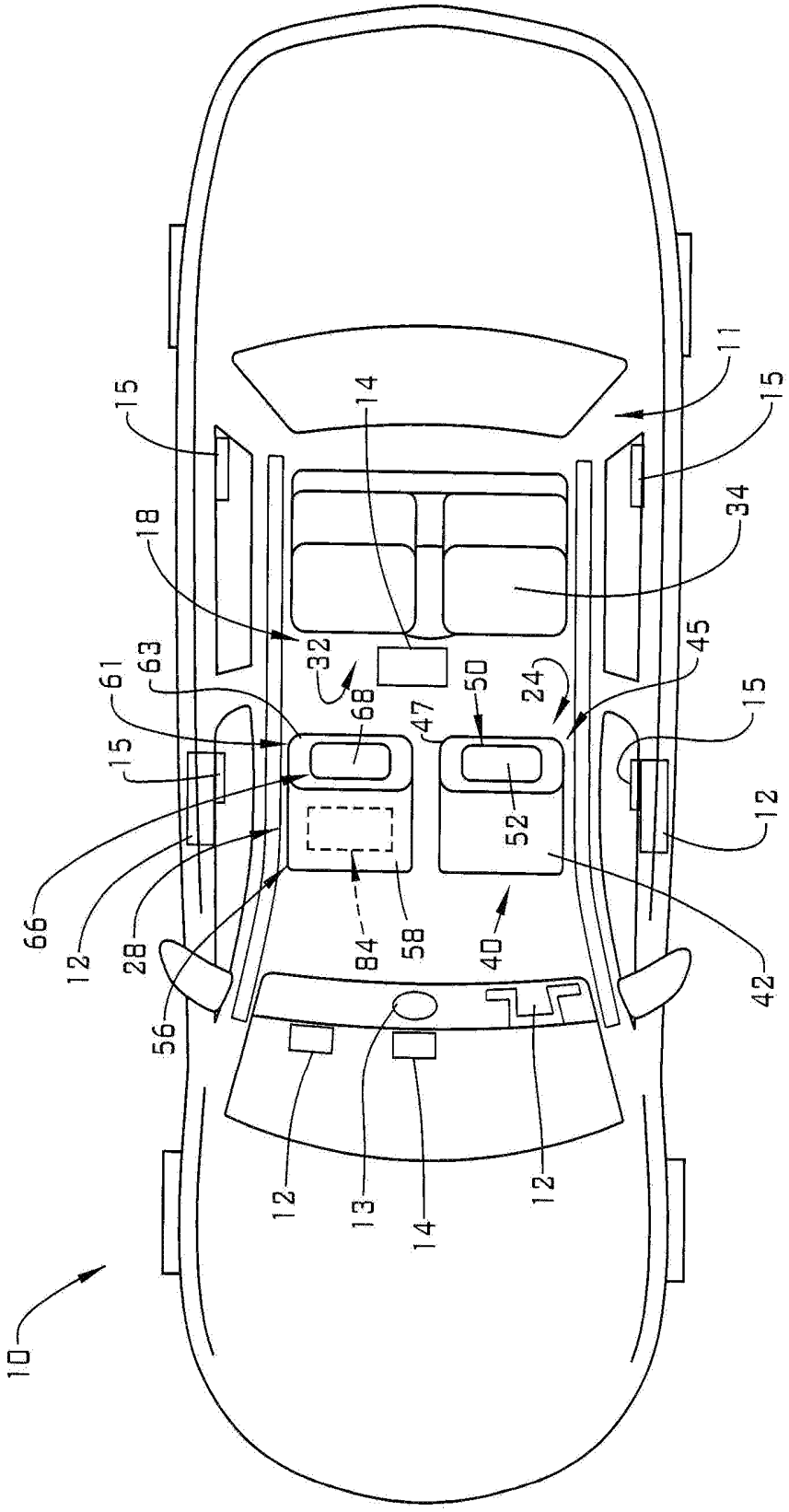


FIG. 1

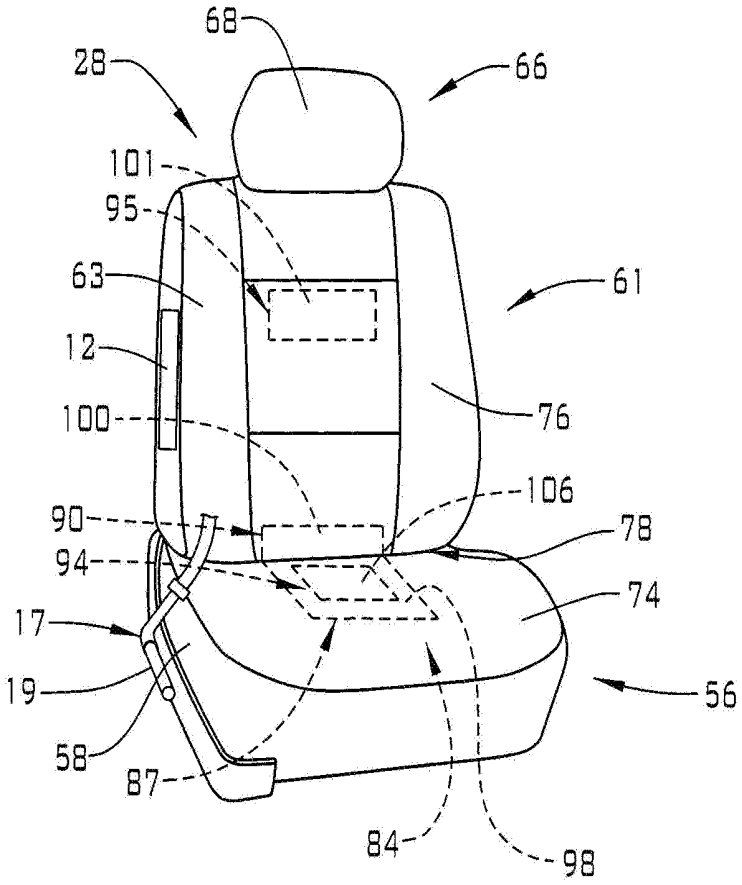

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FIG. 2

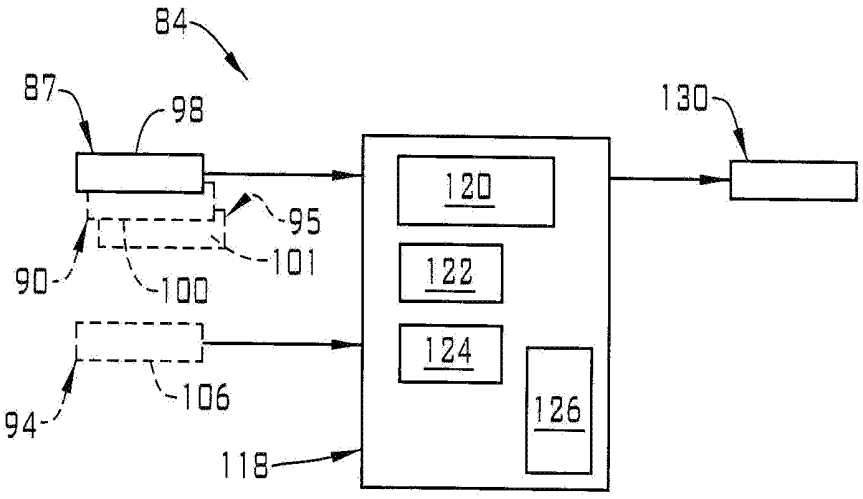
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FIG. 3

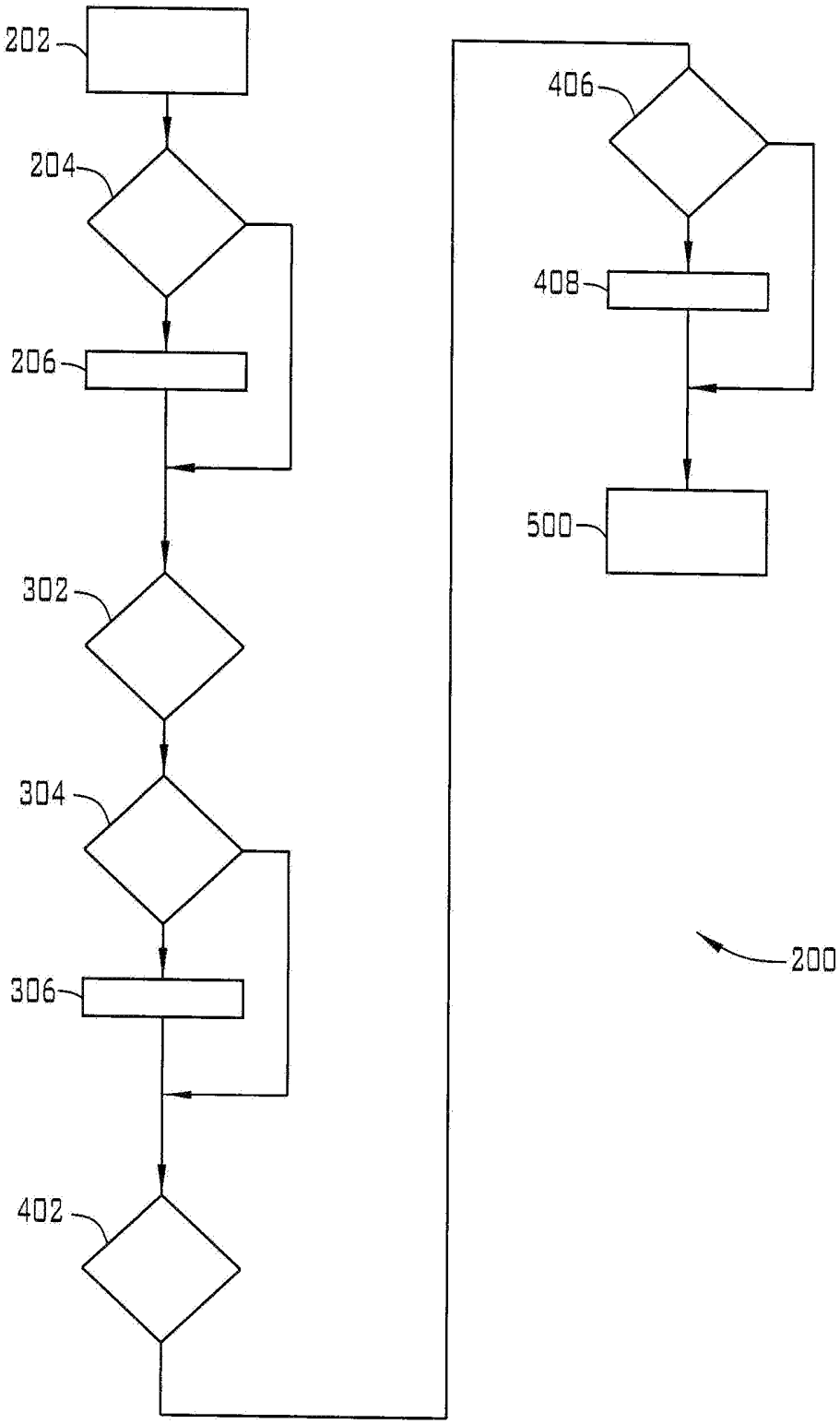

FIG. 4

OCCUPANT SENSING SYSTEM FOR A VEHICLE

INTRODUCTION

[0001] The subject disclosure relates to the art of vehicles and, more particularly, to an occupant sensing system for a vehicle.

[0002] Many current vehicles include sensors for detecting a presence in a vehicle seat. Sensors may take the form of pressure sensors and detect the presence based on weight. Typically, the sensors are connected to a controller that is configured to provide an output signal when a mass having a weight exceeding a predetermined threshold is detected in the seat. The output may be employed to generate a passenger primary restraint warning signal (seat belt), generate signals to control a supplemental restraint system (airbags/seat belt pretensioners) for normally seated adult occupants, or enable entertainment system functionality.

[0003] The predetermined threshold is set to capture people of a certain size and exclude other seat occupants such as pets and packages. The predetermined threshold often times captures children in child safety seats. In many cases, child safety seats do not utilize existing passenger restraints but rather rely on dedicated attachment systems. Thus, often times, a passenger restraint warning may be issued unnecessarily. That is, a sensor may detect the presence of an occupied child safety seat that does not utilize the passenger restraint system. Accordingly, it is desirable to provide a system that can differentiate between an occupant sitting directly on a vehicle seat and an occupant that may occupy a child safety seat that does not use the primary passenger restraint system.

SUMMARY

[0004] Disclosed is an occupant detection system including a vehicle seat having a seat back and a seat base, and a biometric sensor arranged in at least one of the seat back and the seat base. The biometric sensor is configured to detect a physiological characteristic of a seat occupant. A controller is operatively connected to the biometric sensor. The controller is configured to provide an output signal in response to a physiological characteristic detected signal from the biometric sensor.

[0005] In addition to one or more of the features described herein include wherein the biometric sensor comprises at least one of an electrocardiogram (EKG) sensor, an electroencephalogram (EEG) sensor, an electromyography (EMG) sensor, a piezo electric sensor, a neural activity sensor, and a heart activity sensor.

[0006] In addition to one or more of the features described herein include wherein the biometric sensor is arranged in the seat base.

[0007] In addition to one or more of the features described herein include wherein the biometric sensor is arranged in the seat back.

[0008] In addition to one or more of the features described herein include wherein the biometric sensor is arranged between the seat back and the seat base.

[0009] In addition to one or more of the features described herein include wherein the biometric sensor establishes a physiological characteristic detection zone at the vehicle seat.

[0010] In addition to one or more of the features described herein include a non-biometric sensor configured to detect a mass of a seat occupant.

[0011] Also disclosed is a vehicle including a body defining, at least in part, an occupant compartment. At least one vehicle seat is arranged in the occupant compartment. The at least one vehicle seat includes a seat back and a seat base. A biometric sensor is arranged in at least one of the seat back and the seat base. The biometric sensor is configured to detect a physiological characteristic of a seat occupant. A controller is operatively connected to the biometric sensor. The controller is configured to provide an output signal in response to a physiological characteristic detected signal from the biometric sensor.

[0012] In addition to one or more of the features described herein include wherein the biometric sensor comprises at least one of a an electrocardiogram (EKG) sensor, an electroencephalogram (EEG) sensor, an electromyography (EMG) sensor, a piezo electric sensor, a neural activity sensor, and a heart activity sensor.

[0013] In addition to one or more of the features described herein include wherein the biometric sensor is arranged in the seat base.

[0014] In addition to one or more of the features described herein include wherein the biometric sensor is arranged in the seat back.

[0015] In addition to one or more of the features described herein include wherein the biometric sensor is arranged between the seat back and the seat base.

[0016] In addition to one or more of the features described herein include wherein the biometric sensor establishes a physiological characteristic detection zone at the at least one vehicle seat.

[0017] In addition to one or more of the features described herein include a non-biometric sensor configured to detect a mass of a seat occupant.

[0018] Further disclosed is a method of detecting an occupant in a vehicle including sensing a physiological characteristic at a vehicle seat.

[0019] In addition to one or more of the features described herein include wherein sensing the physiological characteristic includes detecting at least one of an electrical activity of a brain, electrical activity of a heart, heart movement, and breathing activity.

[0020] In addition to one or more of the features described herein include detecting an occupant restraint status of the vehicle seat.

[0021] In addition to one or more of the features described herein include providing a signal based on a presence of the physiological characteristic and occupant restraint status.

[0022] In addition to one or more of the features described herein include wherein providing the signal includes at least one of limiting operation status of the vehicle and warning the occupant to buckle a seatbelt, controlling an airbag, a seatbelt pretensioner, an entertainment system, and an HVAC system.

[0023] In addition to one or more of the features described herein include detecting at least one of a child in a child safety seat resting on the vehicle seat, an occupant on the vehicle seat, an out-of-position occupant on the vehicle seat, an animal on the vehicle seat, and an inanimate object on the vehicle seat based on the sensed physiological characteristic.

[0024] The above features and advantages, and other features and advantages of the disclosure are readily apparent

from the following detailed description when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] Other features, advantages and details appear, by way of example only, in the following detailed description, the detailed description referring to the drawings in which:

[0026] FIG. **1** depicts a vehicle including an occupant sensing system, in accordance with an aspect of an exemplary embodiment;

[0027] FIG. **2** depicts a vehicle seat including an occupant sensing system, in accordance with an aspect of an exemplary embodiment;

[0028] FIG. **3** depicts a block diagram illustrating the occupant sensing system, in accordance with an aspect of an exemplary embodiment; and

[0029] FIG. **4** depicts a flow chart illustrating a method of detecting vehicle occupants, in accordance with an aspect of an exemplary embodiment.

DETAILED DESCRIPTION

[0030] The following description is merely exemplary in nature and is not intended to limit the present disclosure, its application or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features. As used herein, the term module refers to processing circuitry that may include an application specific integrated circuit (ASIC), an electronic circuit, a processor (shared, dedicated, or group) and memory that executes one or more software or firmware programs, a combinational logic circuit, and/or other suitable components that provide the described functionality.

[0031] A vehicle, in accordance with an exemplary embodiment, is indicated generally at **10** in FIG. **1**. Vehicle **10** includes a body **11** that defines, at least in part, an occupant compartment **18**. Vehicle **10** may be powered by a variety of systems including internal combustion engines, hybrid electric engines, and electric motors (not shown). Vehicle **10** may be controlled by a driver, be remote controlled, or may be autonomous. Vehicle **10** may include one or more airbag systems **12**. Airbag systems **12** may include side impact airbags, front impact airbags, rollover airbags, knee airbags and the like. Vehicle **10** may also include one or more entertainment systems **14** that can be instrument panel mounted, roof mounted seat mounted, center console mounted, door mounted and the like. In addition, vehicle **10** may include one or more heater/ventilation system HVAC climate controls **13** or other reachable controls **15**.

[0032] A first vehicle seat **24** is arranged in occupant compartment **18**. A second vehicle seat **28** is arranged alongside first vehicle seat **24**, and a third vehicle seat **32** which may take the form of a bench seat **34** is arranged aft of first and second vehicle seats **24** and **28**. At this point, it should be understood that the number, arrangement, and type of vehicle seats may vary. First vehicle seat **24** includes a first portion **40** which may define a seat base **42**, a second portion **45** which may define a seat back **47** and a third portion **50** which may define a head restraint **52**. Second vehicle seat **28** includes a first portion **56** which may define a seat base **58**, a second portion **61** which may define a seat back **63** and a third portion **66** which may define a head restraint **68**.

[0033] Reference will now follow to FIG. **2**, with continued reference to FIG. **1**, in describing second vehicle seat **28** with an understanding that first vehicle seat **24** and third vehicle seat **32** may include similar structure and seatbelt system. Seat base **58** includes a seat base surface **74**, and seat back **63** includes a seat back surface **76**. Second vehicle seat **28** also includes an interface zone **78** that is defined between seat base **58** and seat back **63**. In addition second vehicle seat **28** may interface with a seatbelt system **17** that may include a pretensioner **19**. Pretensioner **19** can be attached to an outboard lower anchor (not separately labeled), a seatbelt buckle (not shown), or a retractor (also not shown).

[0034] In accordance with an aspect of an exemplary embodiment, second vehicle seat **28** includes an occupant detection system **84**. It should be understood that occupant detection system **84** may also be incorporated into first vehicle seat **24** and third vehicle seat **32**, or any other designated seating position within any mode of personal transportation. Occupant detection system **84** includes a first sensor **87** that may be arranged in seat base **58** at seat base surface **74**. A second sensor **90** may be arranged in seat back **63** at seat back surface **76**. Additionally, a third sensor **94** may be arranged in seat base **58** and a fourth sensor **95** may be arranged in seat back **63** at a higher location than second sensor **90**. It should be understood that first sensor **87** and/or second sensor **90** may extend into interface zone **78**. Alternatively, a fifth sensor (not shown) may be arranged in interface zone **78**. It should be understood that the number and location of sensors may vary.

[0035] First sensor **87** takes the form of a biometric sensor **98** that may detect a physiological characteristic of an occupant in second vehicle seat **28**. If provided, second sensor **90** may also take the form of a biometric sensor **100**. Further, fourth sensor **95** may also take the form of biometric sensor **101**. The number and location of biometric sensors may vary and could include sensors at interface zone **78**. Further, biometric sensors may take on various forms including, but not limited to, electrocardiogram (EKG) sensors, electroencephalogram (EEG) sensors such as a Freer neuro monitor based sensor, electromyography (EMG) sensors, and/or sensors that may detect other physiological characteristics including, but not limited to, piezo electric sensors that may detect micro motions associated with a heartbeat and ultra-high impedance heart activity sensors such as Plessy Epic sensors that may be configured to detect breathing, heart rate and the like. In addition, the biometric sensors may be used, in conjunction with non-biometric sensors, for detection of children left in vehicle.

[0036] Also, if provided, third sensor **94** may take the form of a non-biometric sensor **106** that can detect a mass in seat base **58**. Non-biometric sensor **106** may take the form of a load sensor such as a pressure based bladder system, a capacitive sensor, and/or a force resistive sensor that may detect localized pressure at one or more zones on seat base **58**.

[0037] Referring to FIG. **3**, and with continued reference to FIG. **2**, occupant detection system **84** includes a controller **118** that may include a central processing unit (CPU) **120**, a memory module **122**, a signal conditioning module **124** and an occupant detection module **126**. Controller **118** is operatively connected to first sensor **87** and, if provided, second sensor **90** and third sensor **94**. Signal conditioning module **124** conditions signals received through first, second and third sensors **87**, **90** and **94**.

[0038] A conditioned signal may be passed to occupant detection module **126** to determine if an occupant is present on seat base surface **74**. Occupant detection module **126** may also obtain data from load sensor **106**. An "occupant present" output could be based in part on whether a load is detected above a predetermined level that may be stored in memory module **122**. If an "occupant present" determination is made, occupant detection system **84** may output, to an external control system (not shown), or use internally, a signal **130**.

[0039] Occupant detection system **84** may send a another signal (not shown) indicating that an occupant is sitting slightly out of normal seating position, or occupant detection system **84** may output signal **130** when an occupant is sitting across two seating positions. Signal **130** may be used for other vehicle systems such as seat or vehicle comfort features, primary or secondary restraint systems deployment, enabling/disabling vehicle entertainment/convenience features in general. Signal **130** may also be used to report to the primary owner that a child or other object was left behind when the primary occupant exits the vehicle.

[0040] Occupant detection system **84** is configured to discriminate between an occupant on seat base surface **74** and, for example, a child in a child safety seat. Thus, occupant detection system **84** establishes a physiological characteristic detection zone or sensing zone that may extend no more than about four inches (10 centimeters) above seat base surface **74**. It should be understood that the position of each sensor in a vehicle seat may vary in order to achieve one or more of a selected sensing zone, selected seat comfort and sensor durability. Sensors may be arranged between an outer covering and a foam layer, below the foam layer, or the like. Further, biometric sensor **98** and, if provided, biometric sensor **90**, are arranged with a minimal lateral dimension so as to avoid detecting an appendage such as an arm or a leg that may dangle from a child safety seat.

[0041] In addition biometric sensor **100** may be positioned at a lower portion of seat back **63** in order to avoid detecting a back or bottom of a child in a backless booster child safety seat. In this manner, occupant detection system **84** can provide output signal **130** when an occupant is sitting in a vehicle seat and not when the seat is occupied by a child in a child safety seat that does not utilize a seat belt for restraint. As will be discussed herein, output signal **130** may be employed to accurately generate a seat belt warning signal providing a reminder to buckle up, control a supplemental restraint system (airbags **12**, seatbelt pretensioners **19**) based on occupant presence or when an out of position occupant is detected, affect other vehicle systems such as enabling entertainment system **14**, HVAC system controls **13** and functionality of other control **15**, or prevent operation of vehicle **10**.

[0042] Reference will now follow to FIG. **4**, with continued reference to FIGS. **1-3** in describing a method **200** of detecting occupants in a vehicle seat in accordance with an aspect of an exemplary embodiment. In block **202** first sensor **87**, second sensor **90**, and third sensor **94** are powered on by, for example, activating vehicle **10**. Activating vehicle **10** may include, for example, opening a vehicle door (not separately labeled). In block **204** a determination is made whether physiological characteristics are sensed by first sensor **87** and, if provided, second sensor **90**. Also, if provided, non-biometric sensor **106** may provide an input regarding a mass in, for example, second vehicle seat **28**. If no occupant is detected, no action is taken. If an occupant is detected, the input is processed through filtering logic (not shown) and output signal **130** is issued and action may be taken in block **206**. The action may include issuing a seat belt warning, enabling or affecting airbag **12** seatbelt pretensioner **14** deployment, control other vehicle features such as entertainment system **14**, HVAC system controls **13** enable other controls **15**, affect other vehicle features, or vehicle **10** may be prevented from being operated.

[0043] In block **302**, a determination may be made that vehicle **10** is moving. If vehicle **10** is moving, a determination is made, in block **304**, whether an occupant is present in, for example, second vehicle seat **28**. If no occupant is present, no action is taken. If, however an occupant is detected, an action may be taken in block **306**. The action may include stopping vehicle **10**, slowing vehicle **10**, enabling or controlling airbag **12**, seatbelt pretensioner **19** deployment and/or seat heater/ventilation system local HVAC climate control **13** limiting other controls **15** from younger occupants, (limiting power consumption) and/or issuing a seatbelt warning. In block **402**, a determination is made whether vehicle **10** has come to a stop. If vehicle **10** has come to a stop, occupant detection system **84** may again determine whether an occupant is in, for example, second vehicle seat **28** in block **406**. If no occupant is detected, no action is taken. If an occupant is detected, an action may be taken in block **408** including preventing vehicle **10** from starting, issuing a seat belt alert, or the like. In block **500**, occupant detection system **84** may power down.

[0044] Occupant detection system **84** in accordance with exemplary embodiments, employs biometric sensors to detect a physiological characteristic of an occupant in a vehicle seat. An occupant sitting on, for example, vehicle seat **28** presents a stronger signal to an associated one of first and second sensors **87** and **90** than would a child located in a child safety seat. Accordingly, the exemplary embodiments may employ sensed signal strength magnitude threshold to discriminate between an occupant that is directly on, for example, vehicle seat **28** and a child spaced from, for example, seat base surface **74** by a child safety seat. Exemplary embodiments may also detect, via sensed signal strength magnitude an out-of-position occupant that would be physically displaced away from one or more of first, second and fourth sensors **87**, **90**, **95**. In addition, an empty seat could produce either the same signal magnitude as a child on the child safety seat or a lower magnitude response. Thus, the exemplary embodiments may be configured to distinguish between up to six different states depending on sensor location and the use of distinct threshold values for each condition: a) occupant on the seat, b) child in a child safety seat, c) no occupant present, d.) out of position occupant, e) animals and/or f), objects or anything other than human objects on the seat.

[0045] If employed, non-biometric sensor **106** may be utilized to discriminate other living objects that may be resting on, for example, vehicle seat **28**. In an exemplary aspect, non-biometric sensor **106** may be configured to detect weight and controller **118** may determine whether the living object was below a pre-defined mass-based threshold. If below the mass-based threshold, an inference could be made that the living object may be a pet and not a human. Thus, the signal **130** may not be sent for living objects that are below a certain mass based threshold.

[0046] A confined sensing zone is established at each vehicle seat. The confined sensing zone allows the occupant detection system to discriminate between an occupant sitting in the seat and a child that may be in a child safety seat. The occupant is given a warning to use a primary restraint. A warning is not issued if the system determines that a child safety seat occupies the seat. Supplemental restraints such as airbags, seatbelt pretensioners, or other vehicle features such as entertainment systems, HVAC systems controls and other controls may be enabled or disabled. For instance, the child safety seat would not possess a physiological characteristic and thus not be detected by the occupant detection system. The exemplary embodiments ensure that a seat belt warning is issued, supplemental restraints are appropriately controlled and/or other vehicle features and actions are only taken when an occupant is seated on the seat surface.

[0047] The terms "about" and "substantially" are intended to include the degree of error associated with measurement of the particular quantity based upon the equipment available at the time of filing the application. For example, "about" and "substantially" can include a range of ±8% or 5%, or 2% of a given value.

[0048] While the above disclosure has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from its scope. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the disclosure without departing from the essential scope thereof. Therefore, it is intended that the present disclosure not be limited to the particular embodiments disclosed, but will include all embodiments falling within the scope thereof.

What is claimed is:

1. An occupant detection system comprising:
- a vehicle seat including a seat back and a seat base;
- a biometric sensor arranged in at least one of the seat back and the seat base, the biometric sensor being configured to detect a physiological characteristic of a seat occupant; and
- a controller operatively connected to the biometric sensor, the controller being configured to provide an output signal in response to a physiological characteristic detected signal from the biometric sensor.

2. The occupant detection system according to claim **1**, wherein the biometric sensor comprises at least one of an electrocardiogram (EKG) sensor, an electroencephalogram (EEG) sensor, an electromyography (EMG) sensor, a piezo electric sensor, a neural activity sensor, and a heart activity sensor.

3. The occupant detection system according to claim **1**, wherein the biometric sensor is arranged in the seat base.

4. The occupant detection system according to claim **1**, wherein the biometric sensor is arranged in the seat back.

5. The occupant detection system according to claim **1**, wherein the biometric sensor is arranged between the seat back and the seat base.

6. The occupant detection system according to claim **1**, wherein the biometric sensor establishes a physiological characteristic detection zone at the vehicle seat.

7. The occupant detection system according to claim **1**, further comprising: a non-biometric sensor configured to detect a mass of a seat occupant.

8. A vehicle comprising:
- a body defining, at least in part, an occupant compartment;
- at least one vehicle seat arranged in the occupant compartment, the at least one vehicle seat including a seat back and a seat base;
- a biometric sensor arranged in at least one of the seat back and the seat base, the biometric sensor being configured to detect a physiological characteristic of a seat occupant; and
- a controller operatively connected to the biometric sensor, the controller being configured to provide an output signal in response to a physiological characteristic detected signal from the biometric sensor.

9. The vehicle according to claim **8**, wherein the biometric sensor comprises at least one of a an electrocardiogram (EKG) sensor, an electroencephalogram (EEG) sensor, an electromyography (EMG) sensor, a piezo electric sensor, a neural activity sensor, and a heart activity sensor.

10. The vehicle according to claim **8**, wherein the biometric sensor is arranged in the seat base.

11. The vehicle according to claim **8**, wherein the biometric sensor is arranged in the seat back.

12. The vehicle according to claim **8**, wherein the biometric sensor is arranged between the seat back and the seat base.

13. The vehicle according to claim **8**, wherein the biometric sensor establishes a physiological characteristic detection zone at the at least one vehicle seat.

14. The vehicle according to claim **8**, further comprising: a non-biometric sensor configured to detect a mass of a seat occupant.

15. A method of detecting an occupant in a vehicle comprising:

sensing a physiological characteristic at a vehicle seat.

16. The method of claim **15**, wherein sensing the physiological characteristic includes detecting at least one of an electrical activity of a brain, electrical activity of a heart, heart movement, and breathing activity.

17. The method of claim **15**, further comprising: detecting an occupant restraint status of the vehicle seat.

18. The method of claim **17**, further comprising: providing a signal based on a presence of the physiological characteristic and occupant restraint status.

19. The method of claim **18**, wherein providing the signal includes at least one of limiting operation status of the vehicle and warning the occupant to buckle a seatbelt, controlling an airbag, a seatbelt pretensioner, an entertainment system, and an HVAC system.

20. The method of claim **15**, further comprising: detecting at least one of a child in a child safety seat resting on the vehicle seat, an occupant on the vehicle seat, an out-of-position occupant on the vehicle seat, an animal on the vehicle seat, and an inanimate object on the vehicle seat based on the sensed physiological characteristic.

* * * * *

专利名称(译)	用于车辆的乘员感应系统		
公开(公告)号	US20190184853A1	公开(公告)日	2019-06-20
申请号	US15/847044	申请日	2017-12-19
[标]申请(专利权)人(译)	通用汽车公司		
申请(专利权)人(译)	通用汽车环球科技经营有限责任公司		
当前申请(专利权)人(译)	通用汽车环球科技经营有限责任公司		
[标]发明人	THOMAS SCOTT D SALA DOREL M MORROW TRICIA E		
发明人	THOMAS, SCOTT D. SALA, DOREL M. MORROW, TRICIA E. O'BRIEN, CHAD M.		
IPC分类号	B60N2/00 B60R21/015 B60R22/48 A61B5/00		
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外部链接	Espacenet USPTO		

摘要(译)

乘员检测系统包括具有座椅靠背和座椅底座的车辆座椅，以及布置在座椅靠背和座椅底座中的至少一个中的生物传感器。生物识别传感器配置成检测座椅乘员的生理特征。控制器可操作地连接到生物识别传感器。控制器被配置为响应于来自生物传感器的生理特征检测信号提供输出信号。