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(54) **HARDWARE INDEPENDENT MAPPING OF MULTIPLE SENSOR CONFIGURATIONS FOR CLASSIFICATION OF PERSONS**

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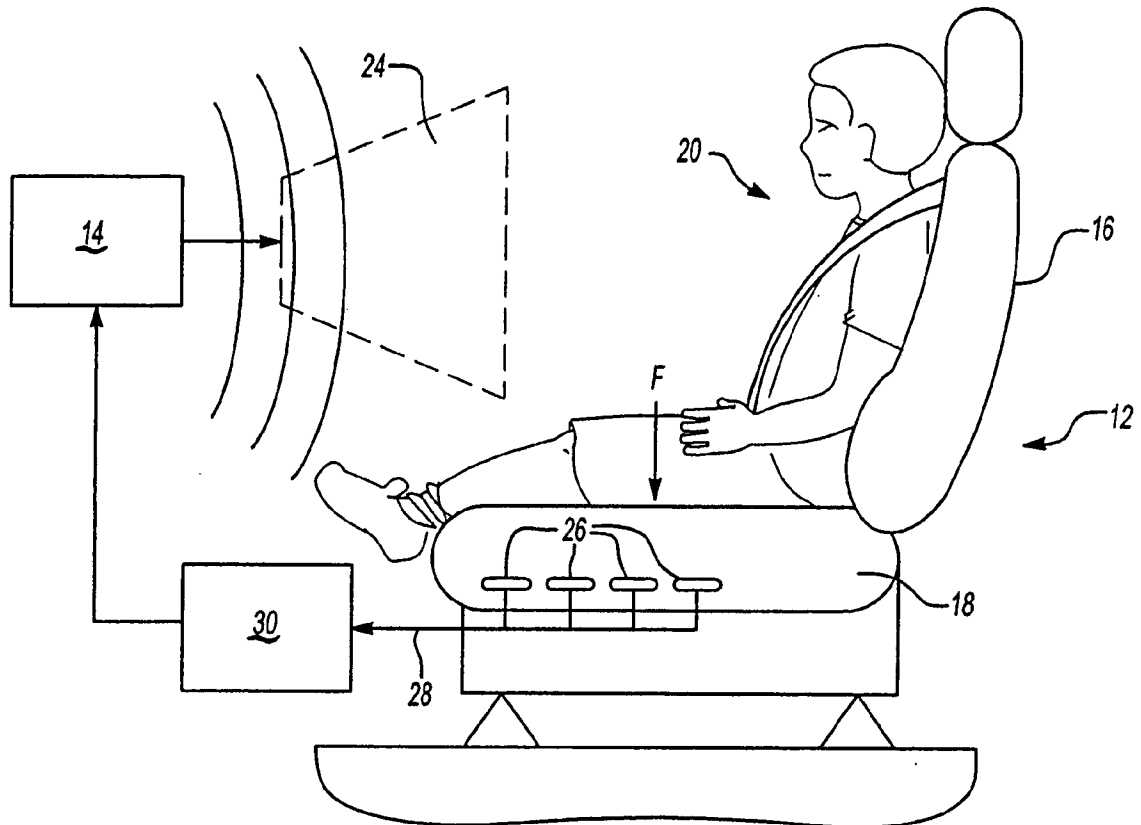   **170 WOOD AVENUE SOUTH**
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(57)   **ABSTRACT**

Sensors are mounted within a seat structure for measuring seat occupant weight. The sensors can be mounted in any one of various sensor configurations. So that common hardware can be used for each different sensor configuration, a virtual matrix is created and output from the sensors is mapped into the virtual matrix. The virtual matrix includes virtual cell locations that do not have a corresponding sensor output; i.e., there are fewer physical cells (sensors) than virtual cell locations in the virtual matrix. A weight output signal from each sensor is mapped into the corresponding position in the virtual matrix and the remaining virtual cell locations have values assigned to them based on data supplied by the surrounding physical cells. Seat occupant weight is determined based on output from the virtual matrix and the occupant is placed into one of the various occupant classifications. Deployment force of a restraint system is controlled based on the classification of the seat occupant.
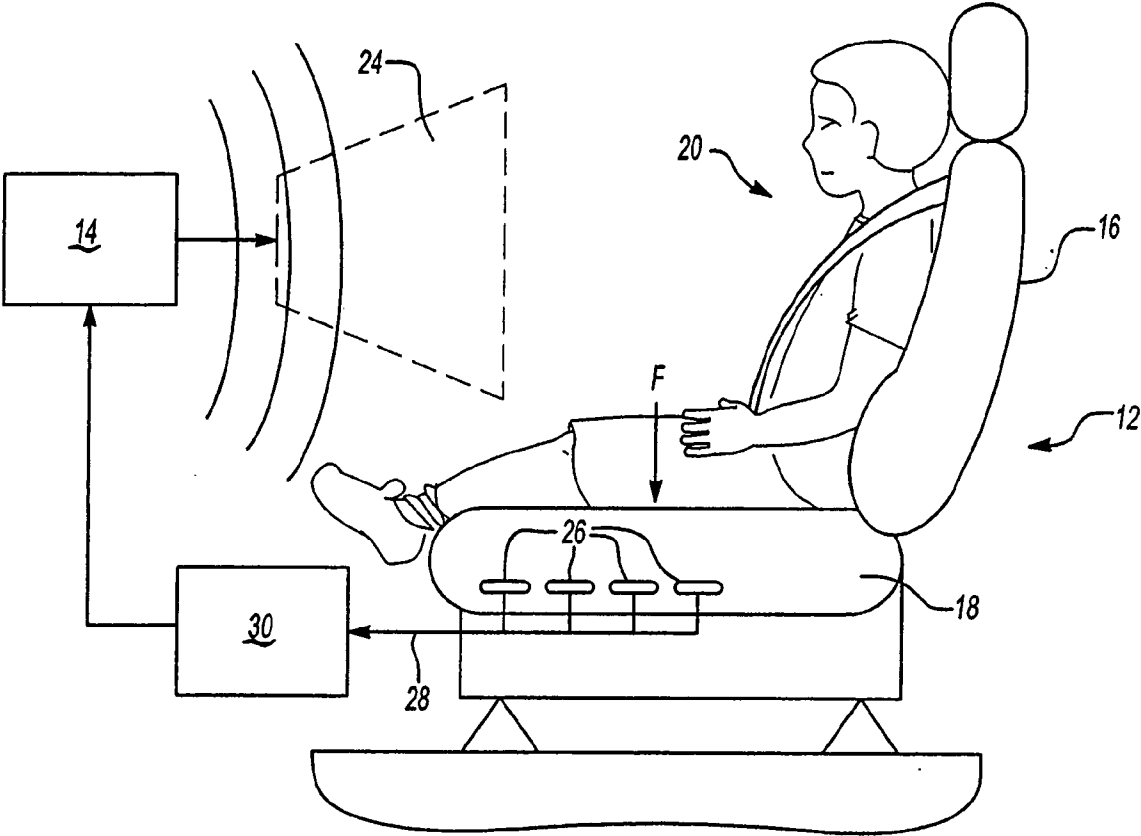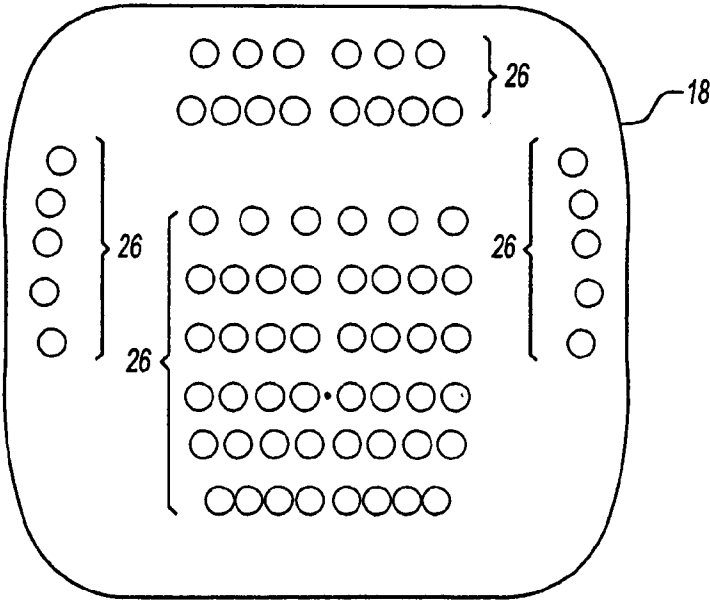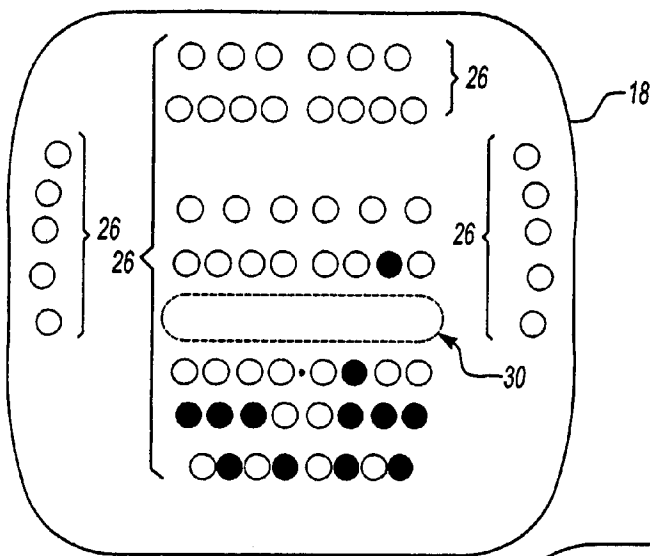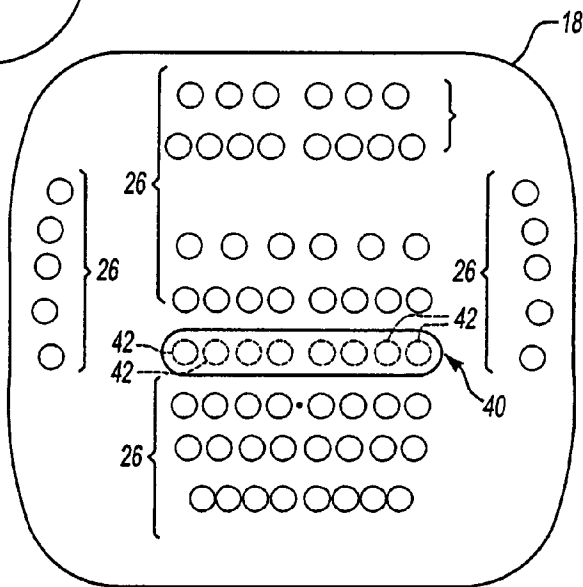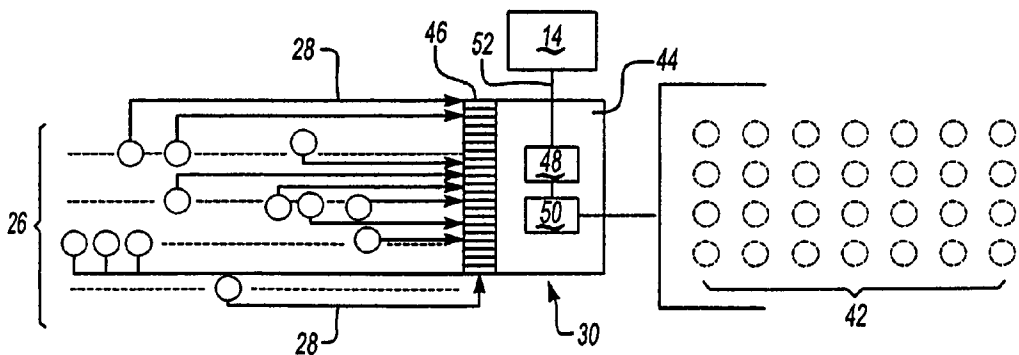
Fig-1

Fig-2

Fig-3A

Fig-3B

Fig-4

HARDWARE INDEPENDENT MAPPING OF MULTIPLE SENSOR CONFIGURATIONS FOR CLASSIFICATION OF PERSONS

RELATED APPLICATIONS

[0001] This application claims priority to provisional applications 60/217,581 filed on Jul. 12, 2000, 60/265,533 filed on Jan. 31, 2001, and 60/280,021 filed on Mar. 30, 2001.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This invention relates to a method and apparatus for classifying vehicle occupants utilizing common hardware for multiple seat sensor configurations. Specifically, physical sensors are mapped into a virtual matrix from which an occupant classification is determined.

[0004] 2. Related Art

[0005] Most vehicles include airbags and seatbelt restraint systems that work together to protect the driver and passengers from experiencing serious injuries due to high-speed collisions. It is important to control the deployment force of the airbags based on the size of the driver or the passenger. When an adult is seated on the vehicle seat, the airbag should be deployed in a normal manner. If there is a small child sitting on the vehicle seat, then the airbag should not be deployed or should be deployed at a significantly lower deployment force. One way to control the airbag deployment is to monitor the weight of the seat occupant. The weight information can be used to classify seat occupants into various groups, e.g., adult, child, infant seat, etc., to ultimately control the deployment force of the airbag.

[0006] There are many different systems for measuring the weight of a seat occupant. One type of system uses a plurality of sensors mounted within the seat bottom cushion. Information from the sensors is sent to system hardware, which utilizes software to combine the output from the sensors to determine the weight of the seat occupant. Often, these sensors must be placed symmetrically within the seat cushion in order to be compatible with the system hardware and software. Sometimes, due to specific seat design or limited space within the seat cushion, symmetrical placement of the sensors is difficult to achieve.

[0007] Another problem with current seat sensor configurations is that each different sensor configuration requires different system hardware and software to account for the variations in sensor placement. Thus, it is difficult to optimize sensor placement because of restrictions with regard to row and column placement of the sensors.

[0008] Thus, it is desirable to have a method and apparatus for classifying seat occupants that can utilize common hardware and software for different seat sensor configurations. The method and apparatus should also work with symmetrical as well as non-symmetrical seat configurations in addition to overcoming the above referenced deficiencies with prior art systems.

SUMMARY OF THE INVENTION

[0009] The subject invention includes a method and apparatus for classifying vehicle occupants utilizing common hardware for multiple seat sensor configurations. Multiple seat sensors are mapped into a virtual matrix from which an occupant classification is determined.

[0010] The seat sensors are preferably mounted within a seat bottom cushion or the seat structure. The sensors can be mounted in a symmetrical or non-symmetrical pattern. The virtual matrix defines an optimal pattern having an optimal number of seat sensor positions.

[0011] In a disclosed embodiment of this invention, the sensors are mounted in a first configuration having one physical sensor for each virtual seat sensor position of the optimal pattern. One occupant weight signal from each sensor is mapped into one corresponding seat sensor position in the optimal pattern. Typically, there are more virtual seat sensors positions in the virtual matrix than there are physical seat sensors mounted within the seat. The difference between the number of virtual cell locations in the virtual matrix and the number of physical sensors mounted within the seat bottom define a remaining number of virtual cell positions. A value is assigned to each of the remaining virtual cell positions based on data from the surrounding physical sensors.

[0012] In a preferred embodiment, electrically erasable programmable read only memory (EEPROM) is used to map the virtual matrix by determining values for each of the remaining number of virtual cell positions. The EEPROM is preferably mounted on a printed circuit board that is common to all seat sensor configurations.

[0013] The subject invention provides a method and apparatus for classifying seat occupants that can be used for symmetrical and non-symmetrical sensor configurations and utilizes common hardware for each different seat sensor configurations. These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 is a schematic representation of a vehicle seat and airbag system incorporating the subject invention.

[0015] FIG. 2 is a schematic view of one seat sensor mounting configuration incorporating the subject invention.

[0016] FIG. 3A is a schematic view of an alternate embodiment of a seat sensor mounting configuration incorporating the subject invention.

[0017] FIG. 3B is a schematic view of the sensor configuration of FIG. 3A incorporating a virtual matrix.

[0018] FIG. 4 is a schematic view of the control system incorporating the subject invention.

DETAILED DESCRIPTION OF AN EXEMPLARY EMBODIMENT

[0019] A vehicle includes a vehicle seat assembly, shown generally at 12 in FIG. 1, and a restraint system including an airbag 14. The seat assembly 12 is preferably a passenger seat and includes a seat back 16 and a seat bottom 18. A vehicle occupant 20 exerts a force F against the seat bottom 18. The vehicle occupant 20 can be an adult, child, or infant in a car seat.

[0020] The airbag system 14 deploys an airbag 24 under certain collision conditions. The deployment force for the airbag 24, shown as deployed in dashed lines in FIG. 1, varies depending upon the type of occupant that is seated on the seat 12. For and adult, the airbag 24 is deployed in a normal manner shown in FIG. 1. If there is child or an infant in a car seat secured to the vehicle seat 12 then the airbag 24 should not be deployed or should be deployed at a significantly lower deployment force. Thus, it is important to be able to classify seat occupants in order to control the various restraint systems.

[0021] One way to classify occupants is to monitor and measure the weight force F exerted on the seat bottom 18. Multiple seat sensors 26 are mounted within the seat bottom 18 for generating occupant weight signals 28 representing portions of the occupant weight exerted against each respective sensor 26. The signals 28 are transmitted to a central control unit 30 and the combined output from the sensors 26 is used to determine seat occupant weight. This process will be discussed in greater detail below.

[0022] Once seat occupant weight is determined, the occupant is classified into one of any of the various predetermined occupant classes, e.g., adult, child, infant, etc. The classification information can be used in a variety of ways. For example, the classification information can be used in a vehicle restraint system including an airbag system 14. The classification information can be transmitted to an airbag control. If the classification indicates that an adult is in the seat 12 then the airbag 24 is deployed in a normal manner. If the classification indicates that a child or infant is the seat occupant then the airbag 24 will not be deployed or will be deployed at a significantly lower deployment force.

[0023] The seat sensors 26 can be mounted within the seat bottom 18 in any of various configurations. The sensors 26 can be mounted in a symmetrical configuration, see FIG. 2, or a non-symmetrical pattern, see FIG. 4. As shown in FIG. 2, the sensors 26 are preferably mounted into the seat bottom 18 in a series of rows and columns. The number of rows and columns can vary, however, FIG. 2 is exemplary of a fully equipped sensor configuration.

[0024] FIG. 3A depicts an alternate sensor mounting configuration. This embodiment has one less row, indicated at 30, than the configuration shown in FIG. 2. Reconfiguring the number of rows and/or columns is typically in response to customer requirements for a seat that includes an extra trench to define seat cushion sections. Or, for smaller seats, it may also be necessary to reduce the number of rows and columns.

[0025] In order to utilize common hardware and software with different seat sensor configurations, a virtual matrix 40 is used to take the place of the missing row as shown in FIG. 3B. The virtual matrix 40 includes virtual cell locations 42 to accommodate the sensors 26 that have been removed from an ideal pattern. The virtual cells 42 are assigned values based on data from the surrounding physical sensors 26. The central control unit 30 can then utilize an algorithm that is common to all seat sensor configurations to determine the seat occupant weight. The occupant can then be classified and the airbag system 14 can control the airbag deployment force based on this classification.

[0026] As discussed above, the weight signals 28 from the physical sensors 26 are transmitted to a central control unit

30. As shown in FIG. 4, the central control unit 30 is preferably a printed circuit board (PCB) 44 that includes a connector 46 with a plurality of ports for connection to the various sensors 26. The PCB 44 includes a central processor unit (CPU) 48 and electrically erasable programmable read-only memory (EEPROM) 50. EEPROM is a type of programmable read-only memory that can be erased by exposing it to an electrical charge and retains its contents even when the power is turned off. The CPU 48 and EEPROM 50 receive the weight signals 28, generate the virtual matrix 40, and map the signals 28 into the matrix 40. The CPU 48 then generates an output signal 52 to the airbag assembly 14 to control airbag deployment based on the seat occupant weight. The operation of PCBs and EEPROMs are well known and will not be discussed in further detail. Also, while PCBs and EEPROMs are preferred, other similar components known in the art can also be used.

[0027] The system operates in the following manner. The sensors 26 are mounted within the seat bottom 18 and generate a plurality of weight signals 28 in response to a weight force F applied to the seat bottom 18. The signals 28 are transmitted to the central control unit 30 where they are mapped into virtual cells 42 in the virtual matrix 40. The output from the virtual cells 42 in the matrix 40 is combined and used to generate an output signal representing the seat occupant weight. Each seat occupant can then be classified into one of a plurality of predetermined occupant weight classes. The classification information can then be used to control any of various restraint systems.

[0028] Preferably, the virtual matrix 40 is configured to define an optimal pattern having an optimal number of virtual cells representing the optimal or maximum number of seat sensor positions. The virtual matrix 40 can be generated as a full matrix having a maximum number of seat sensor positions where each physical sensor 26 is mapped into a virtual cell or the matrix 40 can be generated to represent the "missing" physical sensors 26 that the control unit 30 expects to receive signals from. In this second embodiment, shown in FIGS. 3A and 3B, the weight signals 28 from the physical sensors 28 are combined with the data generated for the virtual row 30 to determine the seat occupant weight.

[0029] In the preferred embodiment, each sensor signal 28 is mapped into the virtual matrix 40 as shown in FIG. 4. As discussed above, the physical seat sensors 26 can be mounted within the seat bottom 18 in any of various configurations including a symmetrical row/column configuration or a non-symmetrical pattern. For example, in one configuration the sensors 26 can be installed within the seat bottom 18 in a pattern that includes one physical sensor 26 for each virtual seat sensor position or cell 42 of the optimal pattern. The control unit 30 would then map one occupant weight signal 28 from each physical sensor into one virtual seat sensor cell 42 in the optimal pattern.

[0030] In the alternative, the physical sensors 26 can be installed in the seat bottom 18 in an alternate pattern that has fewer physical sensors 26 than virtual seat sensor cells in the virtual matrix 40. One occupant weight signal 28 from each of the physical sensors 26 is mapped into a corresponding virtual seat sensor cell 42 in the optimal pattern to define a remaining number of virtual sensor positions. A value for each of the remaining virtual sensor positions is determined based on information supplied by surrounding sensors 26.

[0031] Thus, any number of physical sensors **26** can be mounted within a seat in any type of pattern. The weight signals **28** generated by the sensors **26** are then mapped into the virtual matrix **40** and any remaining virtual cells **42** are assigned values based on information from surrounding sensors. Preferably, electrically erasable programmable read only memory EEPROM is to map the virtual matrix **40** by determining values for each of the remaining number of virtual cells **42** with information from the surrounding cells. Optionally, position tables can be stored within the EEPROM to be used in conjunction with occupant weight signals **28** from surrounding sensors **26** to determine values for each of the remaining number of virtual cells **42**.

[0032] This unique process allows common hardware and software to be used for any seat sensor configuration, which significantly reduces system cost. This means that the same PCB **44** with the same CPU **48** and EEPROM **50** can be used for each different seat sensor configuration. The subject invention also provides a method and apparatus for classifying seat occupants that can be used for symmetrical and non-symmetrical sensor configurations.

[0033] Although a preferred embodiment of this invention has been disclosed, it should be understood that a worker of ordinary skill in the art would recognize many modifications come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.

I claim:

1. A method for classifying vehicle occupants by measuring seat occupant weight comprising the steps of:

(a) mounting a plurality of sensors within a seat structure;

(b) generating a plurality of occupant weight signals from the sensors in response to a weight force applied to the seat structure;

(c) mapping the weight signals into a virtual matrix; and

(d) determining seat occupant weight based on the virtual matrix.

2. The method according to claim 1 including (f) classifying each seat occupant into one of a plurality of predetermined occupant weight classes.

3. The method according to claim 2 including (g) providing seat occupant weight classification to a restraint control.

4. The method according to claim 1 wherein step (a) further includes mounting the sensors in a non-symmetrical pattern.

5. The method according to claim 1 wherein step (a) further includes mounting the sensors in a symmetrical pattern.

6. The method according to claim 1 wherein step (c) further includes generating a virtual matrix to define an optimal pattern having an optimal number of seat sensor positions.

7. The method according to claim 6 wherein step (a) includes mounting the sensors into a first predetermined pattern to define a first seat sensor configuration wherein the first seat sensor configuration includes one sensor for each seat sensor position of the optimal pattern and step (c) further includes mapping one occupant weight signal from each sensor into one corresponding seat sensor position in the optimal pattern.

8. The method according to claim 6 wherein step (a) includes mounting a first number of sensors into a first predetermined pattern to define a first seat sensor configuration wherein the optimal pattern includes more seat sensor positions than the first number of sensors; step (c) further includes mapping one occupant weight signal from each of the first number of sensors into a corresponding seat sensor position in the optimal pattern to define a remaining number of virtual sensor positions, and determining a value for each of the remaining virtual sensor positions based on surrounding sensors from the first number of sensors.

9. The method according to claim 8 wherein step (a) includes mounting a second number of sensors into a second predetermined pattern to define a second seat sensor configuration that is different from the first seat sensor configuration wherein the optimal pattern includes more seat sensor positions than the second number of sensors; step (c) further includes mapping one occupant weight signal from each of the second number of sensors into a corresponding seat sensor position in the optimal pattern to define a remaining number of virtual sensor positions, and determining a value for each of the remaining virtual sensor positions based on surrounding sensors from the second number of sensors.

10. The method according to claim 1 including providing hardware for receiving the occupant weight signals, storing the virtual matrix, and mapping the weight signals into the virtual matrix.

11. The method according to claim 10 wherein step (a) includes mounting the sensors into one of multiple different seat sensor configurations and further including using common hardware for each different seat sensor configuration.

12. The method according to claim 10 wherein step (a) includes mounting the sensors into one of multiple different seat sensor configurations and further including using identical hardware for each different seat sensor configuration.

13. The method according to claim 6 wherein step (a) includes mounting a predetermined number of sensors within the seat structure wherein the predetermined number is less than the optimal number of seat sensor positions the difference defining a remaining number of virtual positions and wherein step (c) further includes using a electrically erasable programmable read only memory to map the virtual matrix by determining values for each of the remaining number of virtual positions.

14. The method according to claim 13 including storing position tables within electrically erasable programmable read only memory to be used in conjunction with occupant weight signals from surrounding sensors to determine values for each of the remaining number of virtual positions.

15. A method for classifying vehicle occupants by measuring seat occupant weight comprising the steps of:

(a) mounting a plurality of sensors within a seat structure in a physical matrix having a first pattern with a first predetermined number of rows and a first predetermined number of columns;

(b) generating a plurality of occupant weight signals from the sensors in response to a weight force applied to the seat structure;

(c) generating a virtual matrix having a second pattern with a second predetermined number of rows and second predetermined number of columns wherein the second predetermined number of rows is greater than or equal to the first predetermined number of rows and/or

the second predetermined number of columns is greater than or equal to the first predetermined number of columns;

(d) mapping the weight signals from the physical matrix into the virtual matrix by mapping one weight signal from each sensor location in the first predetermined number of rows and columns into a corresponding virtual location in the second predetermined number of rows and columns; and

(e) combining data from each of the second predetermined number of rows and columns to determine seat occupant weight.

16. The method of claim 15 wherein the difference between the second predetermined number of rows and columns and the first predetermined number of rows and columns defines virtual sensor locations and step (d) further includes determining a value for each virtual sensor location by using data from the surrounding sensors in the first predetermined number of rows and columns.

17. The method of claim 16 wherein step (a) includes having a plurality of different first patterns to define a plurality of sensor configurations and including the step of using common hardware and software for every sensor configuration.

18. The method of claim 17 including using electrically erasable programmable read only memory for the mapping.

19. A system for determining seat occupant weight comprising:

a plurality of sensors mounted within a seat structure for generating a plurality of occupant weight signals in response to a weight force applied to said seat structure; and

a control unit electrically connected to said sensors for receiving said signals and mapping said signals into a virtual matrix to generate an output signal representing seat occupant weight.

20. A system according to claim 19 wherein said control unit generates said virtual matrix to define an optimal pattern having an optimal number of seat sensor positions and wherein said plurality of sensors are mounted within said seat structure to establish a first sensor configuration having a first predetermined number of sensors that is less than the optimal number of sensors to define a number of remaining virtual sensor positions, said control unit mapping one occupant weight signal into a corresponding seat sensor position in said virtual matrix and assigning a value to each of said remaining virtual sensor positions by utilizing weight signals from surrounding sensors.

21. A system according to claim 19 wherein said sensors are mounted within said seat structure in one of a plurality of seat sensor configurations and wherein said control unit includes hardware that is common to each of said seat sensor configurations.

22. A system according to claim 19 wherein said control unit includes electrically erasable programmable read only memory.

23. A system according to claim 19 wherein said control unit includes a printed circuit board having a plurality of connectors for attachment to said sensors and a central processing unit for generating said virtual matrix and mapping said weight signals into said virtual matrix.

24. A system according to claim 19 including a restraint control wherein said output signal is classified into one of a plurality of predetermined occupant weight classes and transmitted to said restraint control.

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