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FLIGHT SIMULATION SYSTEMS AND METHODS

TECHNOLOGICAL FIELD

The presently disclosed subject matter relates to flight simulation systems and methods, in particular for enabling training.

5 BACKGROUND

Pilots who undergo high g-forces maneuvers are subject to physiological stress that can lead to g-induced loss of consciousness (G-LOC), and/or vision problems such as loss of vision, tunnel vision and so on. High g-forces can cause blood to flow away from the brain, and can cause breathing difficulties.

10 The ability of the pilot to anticipate the physiological stress and to initiate anti-g straining maneuvers (AGSM) or the like can significantly increase survivability of the pilot, and training systems and methods are known that attempt to train pilots to increase improve response to g-forces.

By way of non-limiting example, DE102020205898 discloses a training device
15 for training of a pilot of an aircraft, comprising: a display device to display a perceptible effect by the pilot signal, the effect signal a flight maneuvers induced acceleration forces caused by physical degradation of the pilot, a sensing device for sensing a muscle activity of at least one muscle of the pilot and for generating an activity signal, the activity signal represents the sensed muscle activity, and comprising a determiner for determining of the
20 effect signal generated at least in dependency of the activity signal and a predetermined acceleration signal, wherein the predetermined acceleration signal represents the flight maneuver conditional acceleration forces.

Also by way of non-limiting example, US 11,109,817 discloses systems and methods for measuring oxygenation signals. The method includes positioning an
25 oxygenation measuring system over a side portion of a head of a user, wherein the oxygenation measuring system includes an outer shell, a gel seal coupled to the outer

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shell, a near-infrared spectroscopy sensor configured to measure oxygenation signals from a user, a printed circuit board coupled to the near-infrared spectroscopy sensor, and a bone conducting transducer. The method further includes measuring the oxygenation signals from the user using the near-infrared spectroscopy sensor, recording data
5 pertaining to the measured oxygenation signals of the user, and comparing the data, using the printed circuit board, with known human performance data.

Also by way of non-limiting example, US 9,799,233 discloses an apparatus for operating a simulator with a special impression of reality. The apparatus is configured for learning how to control a vehicle moving in three-dimensional reality. Controllable
10 systems for detecting human stress reactions are provided. The controllable systems may be configured for sensing the resistance of the skin and for detecting movements of persons and physiognomy.

Also by way of non-limiting example, US 9,576,496 discloses a system for training a subject to recognize the onset of hypoxia, the system including (i) a flight
15 simulation system, and (ii) a hypoxia induction system, wherein the flight simulation system is operably linked to the hypoxia induction system. The system provides a tool for pilot training to a pilot, allowing for the delivery of standardized training programs where the tasks required for the operation of an aircraft are able to be coordinated with an induction of hypoxia in the subject. Such a system is also able to provide an assessment
20 tool to demonstrate when a pilot has had sufficient training in recognizing the effects of hypoxia.

Also by way of non-limiting example, FR 2,717,289 discloses a seat held on a tubular swiveling section and pivots independently in two axes. The axes are geared, allowing movement in two right angular planes. Programmed calibrated movements can
25 be input. The user wears a helmet with an image viewer in front. The image viewer totally masks outside points of reference. The helmet has a microphone and earphones. The seat has a manual command and vibration system. The angle of inclination of the seat can vary as a function of image speed.

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GENERAL DESCRIPTION

According to a first aspect of the presently disclosed subject matter here is provided a flight simulation system for enabling g-force training, comprising

5 a seating system configured for accommodating a human occupant and for providing to the human occupant physically simulated flight conditions corresponding to predetermined real flight conditions, said predetermined real flight conditions including g-forces, wherein said physically simulated flight conditions include application of non-g forces to the human occupant corresponding to said g-forces, and wherein said g-forces are considered sufficient
10 to provide g-force induced physiological stress to the human occupant;

a sensor arrangement configured for providing real-time feedback data of predetermined physiological parameters of the human occupant, in operation of the flight simulation system with the human occupant accommodated in the seating system, wherein said predetermined physiological parameters are
15 indicative of said g-force induced physiological stress;

a controller configured for controlling the seating system to provide said physically simulated flight conditions.

For example, said predetermined real flight conditions include real control moments in pitch, yaw and roll, and wherein said physically simulated flight conditions
20 further include physically simulated control moments in pitch, yaw and roll applied to the human occupant corresponding to said respective real control moments in pitch, yaw and roll.

Additionally or alternatively, for example, said g-force induced physiological stress includes at least one of: breathing difficulties; blood loss in the brain; reduced
25 vision; tunnel vision; loss of vision; loss of consciousness.

Additionally or alternatively, for example, the flight simulation system further comprises a display device coupled to the controller and to the sensor system, the display device being configured for displaying to the human occupant at least said real-time feedback data. For example, the display device is configured for comparing said real-time
30 feedback data with first datum feedback data representative of first threshold levels of said predetermined physiological parameters, wherein said first threshold levels are

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considered to be representative of safe levels for said predetermined physiological parameters at least sufficient for avoiding onset of g-force induced loss of consciousness. Additionally or alternatively, for example, the display device is configured for alerting the human occupant responsive to said real-time feedback data approaching or exceeding
5 second datum feedback data representative of second threshold levels of said predetermined physiological parameters, wherein said second threshold levels are considered to be representative of minimum unsafe levels for said predetermined physiological parameters corresponding to onset of g-force induced loss of consciousness.

10 For example, the display device is configured for prompting the human occupant to initiate anti-g straining maneuvers (AGSM) for managing levels of said predetermined physiological parameters at least when said second threshold level is being approached or exceeded, and for reducing said levels to said first threshold level. For example, said AGSM comprises application of muscle tension procedures to predetermined muscle
15 groups by the human occupant. For example, said predetermined muscle groups include muscles in the abdomen and extremities of the human occupant.

Additionally or alternatively, for example, said AGSM comprises the human occupant applying rapid static contractions of muscles in at least one of the arms, legs and abdomen.

20 Additionally or alternatively, for example, said AGSM comprises the human occupant applying specialized breathing cycle configured to maintain air pressure in the lungs.

Additionally or alternatively, for example, said sensor arrangement includes a sensor configured for determining an electromyography (EMG) parameter of the human
25 occupant.

Additionally or alternatively, for example, said sensor arrangement includes a sensor configured for determining a pneumograph parameter of the human occupant.

Additionally or alternatively, for example, said sensor arrangement includes a sensor configured for determining a brain blood oxygenation level parameter of the
30 human occupant.

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Additionally or alternatively, for example, said seating system comprises a mechanical force application system configured for applying said non-g forces to the human occupant corresponding to said g-forces being simulated by the system.

For example, said mechanical force application system comprises a plurality of
5 belts configured for being peripherally wound around respective body portions of the human occupant when seated with respect to the seating system, the belts being coupled to a tensioning device, the tensioning device being configured for selectively tightening or loosening a respective abutment contact between each respective said belt and the respective body portion of the human occupant, such as to respectively increase or
10 decrease a magnitude of said non-g forces to the respective body portion of the human occupant corresponding to predetermined g-forces being simulated by the system.

For example, said mechanical force application system comprises a plurality of inflatable members configured for being peripherally wound around respective body portions of the human occupant when seated with respect to the seating system, the
15 inflatable members being coupled to an inflation device, the inflation device being configured for selectively inflating or deflating the respective inflatable members to respectively increase or decrease a respective abutment pressure between each respective said inflatable member and the respective body portion of the human occupant, such as to respectively increase or decrease a magnitude of said non-g forces to the respective
20 body portion of the human occupant corresponding to predetermined g-forces being simulated by the system.

Additionally or alternatively, for example, said body portions include at least one of: the arms; the legs; the shoulders; the abdomen; the head; the chest; the neck.

Additionally or alternatively, for example, the seating system comprises a seat
25 including a seat cushion and a backrest, the seat being coupled to a rotary motion inducing structure configured for selectively generating said simulated control moments in pitch, yaw and roll to the seat corresponding to said real control moments in pitch, yaw and roll.

For example, said rotary motion inducing structure comprises a movable frame pivotably mounted to a base structure, wherein the seat is pivotably mounted to the
30 movable frame, such as to enable the seat to be pivoted with respect to the base structure

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in one, two or three degrees of freedom, and wherein said rotary motion inducing structure comprises a driving system for selectively pivoting the seat with respect to the base structure in said one, two or three degrees of freedom, to provide said control moments in pitch, yaw and roll to the seat responsive to receiving actuation command from the
5 controller corresponding to said predetermined respective aircraft control moments being simulated by the flight simulation system.

For example, the seat is mounted in a cockpit mock-up, and wherein said rotary motion inducing structure comprises a movable frame pivotably mounted to a base structure, wherein the cockpit mock-up is pivotably mounted to the movable frame, such
10 as to enable the seat to be pivoted with respect to the base structure in one, two or three degrees of freedom, and wherein said rotary motion inducing structure comprises a driving system for selectively pivoting the cockpit mock-up with respect to the base structure in said one, two or three degrees of freedom, to provide said control moments in pitch, yaw and roll to the cockpit mock-up responsive to receiving actuation command
15 from the controller corresponding to said predetermined respective aircraft control moments being simulated by the flight simulation system.

Additionally or alternatively, for example, the flight simulation system comprises a visual display device configured for providing a visual display of a virtual simulation corresponding to said flight conditions from a subjective visual viewpoint of the human
20 occupant when accommodated in said seating system. For example, the visual display device is in the form of virtual reality goggles.

Additionally or alternatively, for example, the seating system comprises a manual control actuable by the human occupant when the human occupant is accommodated in the seating system, said manual control being operatively connected to the controller,
25 wherein the manual control is configured for enabling the human occupant to define the flight conditions being simulated by manipulating said manual control, and wherein the manual control is configured for providing control signals to the controller to thereby cause the seating system to provide a corresponding said physical flight simulation to the human occupant corresponding to said predetermined g-forces and said predetermined
30 respective aircraft control moments responsive to manual actuation of the manual control by the human occupant. For example, said manual control is in the form of a joystick.

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According to a second aspect of the presently disclosed subject matter, there is provided a method for enabling g-force training, comprising:

providing a flight simulation system as defined herein regarding the first aspect of the presently disclosed subject matter;

5 accommodating a human occupant in the flight simulation system;

choosing a real flight condition to be simulated by the flight simulation system;

causing the controller to provide to the human occupant a physical simulated flight condition corresponding to said real flight condition, said physical simulated flight condition including corresponding physically simulated non-g forces and optionally corresponding physically simulated respective aircraft control moments.

For example, said real flight conditions include g-forces within a range 0 to 9, and comprising the step of operating said seating system to cause application to the human occupant of said physically simulated g-forces in the form of respective non-g forces.

For example, said real flight conditions include g-forces up to 35g, and comprising the step of operating said seating system to cause application to the human occupant of said physically simulated g-forces in the form of respective non-g forces.

Additionally or alternatively, for example, the method comprises providing real-time feedback data of said predetermined physiological parameters of the human occupant at said physically simulated flight conditions.

Additionally or alternatively, for example, the method comprises an AGSM step wherein the human occupant initiates anti-g straining maneuvers (AGSM) for managing levels of said predetermined physiological parameters responsive to application of said non-g forces to the human occupant.

For example, the AGSM step comprises the following steps:

- (a) setting said real flight conditions to correspond to a minimum g-force greater than 1.0;

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- (b) providing real-time feedback data of predetermined physiological parameters of the human occupant at the real flight conditions of step (a);
- (c) the human occupant initiates anti-g straining maneuvers (AGSM) for managing levels of said predetermined physiological parameters responsive to application of said non-g forces to the human occupant corresponding to said g-force;
- (d) providing real-time feedback data of predetermined physiological parameters of the human occupant at the flight conditions of step (c);
- (e) setting said real flight conditions to correspond to an increment in said g-force;
- (f) repeating steps (c) and (d) at the increased g-force of step (e);
- (g) checking whether the increased g-force of step (e) exceeds predetermined safety limits, wherein:
- if the increased g-force of step (e) exceeds predetermined safety limits, terminate the said flight simulation; or
 - if the increased g-force of step (e) does not exceed said predetermined safety limits repeating steps (e) to (g).

For example, said minimum g-force is 1.5g.

Additionally or alternatively, for example, said increment in said g-force is 0.5g.

Additionally or alternatively, for example, said predetermined safety limits corresponds to a g-force of 9g.

Additionally or alternatively, for example, said predetermined safety limits corresponds to a g-force of 35g.

Additionally or alternatively, for example, said step of initiating said AGSM comprises the human occupant applying muscle tension procedures to predetermined muscle groups.

For example, said predetermined muscle groups include muscles in the abdomen and extremities of the human occupant.

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Additionally or alternatively, for example, said step of initiating said AGSM comprises the human occupant applying rapid static contractions of muscles in the arms, legs and abdomen.

Additionally or alternatively, for example, said step of initiating said AGSM
5 comprises the human occupant applying specialized breathing cycle configured to maintain air pressure in the lungs.

Additionally or alternatively, for example, said sensor arrangement operates to provide an electromyography (EMG) parameter of the human occupant.

Additionally or alternatively, for example, said sensor arrangement operates to
10 provide a pneumograph parameter of the human occupant.

Additionally or alternatively, for example, said sensor arrangement operates to provide a brain blood oxygenation level parameter of the human occupant.

Additionally or alternatively, for example, said real flight conditions include any one of: evasive maneuvers, dog fight maneuvers, diving maneuvers.

15 A feature of at least one example of the presently disclosed subject matter is a training system and a training method are provided enabling human occupants to be physically subjected to non-g forces corresponding to real g-forces of real flight conditions, and for enabling the human occupants to experience such non-g forces in a range of real flight maneuvers.

20 Another feature of at least one example of the presently disclosed subject matter is a training system and method is provided enabling human occupants to be physically subjected to non-g forces corresponding to g-forces of real flight conditions, and for enabling the human occupants to train to resist the effects of such forces.

Another feature of at least one example of the presently disclosed subject matter
25 is a training system and method is provided enabling human occupants to be physically subjected to non-g forces corresponding to g-forces of aircraft seat ejection conditions.

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BRIEF DESCRIPTION OF THE DRAWINGS

In order to better understand the subject matter that is disclosed herein and to exemplify how it may be carried out in practice, examples will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

5 **Fig. 1** schematically illustrates a flight simulation system according to an example of the presently disclosed subject matter.

Fig. 2(a) shows in side view a seat including a mechanical force application system according to a first example of the presently disclosed subject matter; **Fig. 2(b)** shows in front view the example of Fig. 2(a).

10 **Fig. 3(a)** shows in side view a seat including a mechanical force application system according to a second example of the presently disclosed subject matter; **Fig. 3(b)** shows in front view the example of Fig. 3(a).

Fig. 4 schematically illustrates an auxiliary display device comprised in the example of Fig. 1.

15 **Fig. 5** schematically illustrates a training method according to an example of the presently disclosed subject matter.

Fig. 6 schematically illustrates sub-steps of a training step of the example of Fig. 5.

20 DETAILED DESCRIPTION

Referring to Fig. 1, a flight simulation system for enabling g-force training according to a first example of the presently disclosed subject matter, generally designated **100**, comprises a seating system **300**, a sensor arrangement **500**, and a controller **900**.

As will become clearer herein, the seating system **300** is configured for
25 accommodating a human occupant **HO** and for providing to the human occupant **HO** physically simulated flight conditions **PFC** corresponding to predetermined real flight conditions **RFC**. For example, the human occupant **HO** can be a pilot, navigator, weapons specialist, passenger, and so on.

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Also as will become clearer herein, the predetermined real flight conditions **RFC** include at least real g-forces, while the physically simulated flight conditions **PFC** include at least physical application of non-g forces to the human occupant **HO** corresponding to said g-forces. Such real g-forces are considered sufficient to provide g-force induced
5 physiological stress to the human occupant **HO**.

Herein, said g-force induced physiological stress includes at least one of: breathing difficulties; blood loss in the brain; reduced vision; tunnel vision; loss of vision; g-LOC. On the other hand, herein, said g-force induced physiological stress does not include other types of physiological stress that are not a direct result of the application of g-forces to the body,
10 and thus excludes, for example, hypoxemia (low oxygen supply in blood) or hypoxia (low oxygen supply in body tissues).

In at least this example, the predetermined real flight conditions **RFC** can also include real control moments in pitch **RP**, yaw **RY** and roll **RR**, and the physically simulated flight conditions **PFC** can thus further include physically simulated control moments in pitch
15 **PP**, yaw **PY**, and roll **PR** applied to the human occupant **HO** corresponding to the respective real control moments in pitch **RP**, yaw **RY**, and roll **RR**.

In at least this example, the seating system **300** comprises a seat **320** including a seat cushion **322** and a backrest **324**, and the seat **320** can be similar to a pilot seat used in aircraft for example, at least in terms of the size, look and/or feel experienced by the human occupant
20 **HO**. In at least this example, the seat **320** also comprises a footrest **328** and a lower leg support **326** extending between the front end of the seat cushion **324** and the footrest **328**. In at least this example, the seat **320** also comprises a headrest **321** vertically projecting away from the top end of the backrest **324**. While not shown, the seat **320** can optionally also comprise armrests, which optionally can also be adjustable in height, for example.

25 In at least some examples, the relative proportions and/or angular dispositions between at least some of the seat components, including one or more of the headrest **321**, backrest **322**, seat cushion **324**, lower leg support **326**, footrest **328**, armrests, are adjustable to cater for a range of human occupants **HO** of different sizes.

Thus, when the human occupant **HO** is seated in the seat **320**, the head is in abutment
30 with the headrest **321**, the upper torso including the chest and midriff is in abutment with the

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backrest **322**, the lower torso and the upper legs are in abutment with the seat cushion **324**, the lower legs are in abutment with the lower leg support **326**, and the feet are in abutment with the foot support **328**, while the arms are in abutment with the armrests.

The seating system **300** further comprises a rotary motion inducing structure **400**
5 coupled to the seat **320**. The rotary motion inducing structure **400** is configured for selectively generating the physically simulated control moments in pitch **PP**, yaw **PY**, and roll **PR** to the seat **320**, and thus to the human occupant **HO**, corresponding to the respective real control moments in pitch **RP**, yaw **RY**, and roll **RR**.

By "physically simulated control moments" in pitch **PP**, yaw **PY**, and roll **PR** is
10 meant that physical control moments (respectively in pitch, yaw and roll) are physically generated by the rotary motion inducing structure **400** and physically applied to the human occupant **HO** via the seat **320**, and that the human occupant **HO** physically experiences such physically generated control moments, independently of the human occupant **HO** being optionally informed (for example via a computer screen or via a human instructor) that the
15 human occupant **HO** is being, or should imagine being, subjected to such control moments.

In at least this example, the rotary motion inducing structure **400** comprises a movable frame **420** and a fixed base structure **450**. The movable frame includes a first frame member **422** pivotably mounted with respect to a second frame member **426** about a roll axis **RA**. The seat **320** is pivotably mounted to the movable frame **420**, in particular to the
20 first frame member **422**, about a pitch axis **PA**. For example, the first frame member **422** is U-shaped, having a pair of laterally spaced arms **423** projecting from a base member **421**, and the seat **320** is pivotably mounted to the free ends of the arms **423**. The movable frame **420**, in particular the second frame member **426**, is pivotably mounted to the base structure **450** about a yaw axis **YA**. For example, the second frame member **426** is L-shaped, having
25 a lower base element **427** and a vertical arm **428** vertically projecting from the base element **427**. The base member **421** is pivotably mounted to the vertical arm **428** about the roll axis **RA**, while the base element **427** is pivotably mounted to the base structure **450** via the yaw axis **YA**. In this manner, the rotary motion inducing structure **400** enables the seat **320** to be pivoted with respect to the base structure **450** in one, two or three degrees of freedom, i.e.,
30 about one or more of the pitch axis **PA**, the roll axis **RA** and the yaw axis **YA**.

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The rotary motion inducing structure **400** further comprises a driving system **490** for selectively pivoting the seat **320** with respect to the base structure **450** in the aforesaid one, two or three degrees of freedom, to provide the physically simulated control moments in pitch **PP**, yaw **PY**, and roll **PR** to the seat **320** responsive to receiving actuation commands
5 from the controller **900** corresponding to the predetermined respective aircraft real control moments in pitch **RP**, yaw **RY**, and roll **RR** being simulated by the flight simulation system **100**.

For example, the driving system **490** comprises a plurality of motors, for example electrical motors, and/or pneumatic motors, and/or hydraulic motors, for selectively pivoting
10 the seat **320** with respect to the first frame member **422** about the pitch axis **PA**, for selectively pivoting the first frame member **422** with respect to the second frame member **426** about the roll axis **RA**, and for selectively pivoting the second frame member **426** with respect to the base structure about the pitch axis **PY**.

The controller **900** is operatively coupled to the driving system **490**, for example via
15 cables or wirelessly, enabling the driving system **490** to apply physically simulated control moments in one or more of pitch **PP**, yaw **PY**, and roll **PR** to the seat **320**.

In at least this example, the seating system **300** further comprises a visual display **470**, for example a panoramic display, configured for providing a visual display of a virtual simulation corresponding to the real flight conditions **RFC** from a subjective visual
20 viewpoint of the human occupant **HO** when accommodated in seating system **300**.

The display **470** is operatively coupled to the controller **900**.

For example, the display **470** provides a computer generated real-time forward view (with respect to the human occupant **HO**) of the outside environment corresponding to and consistent with the real flight conditions **RFC**, and the viewing angle of the outside
25 environment and speed of movement of fixed items (for example the ground or horizon) in the display change consistent with the real g-forces and real control moments in pitch **RP**, yaw **RY**, and roll **RR** being simulated by the flight simulation system **100**.

In at least this example, the display **470** is in the form of virtual reality goggles **472**, for example including any one of VR goggles, AR goggles, or XR goggles, which are worn
30 by the human occupant **HO**.

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However, in alternative variations of this example, the display **470** can be non-connected physically to the human occupant **HO**, for example in the form of one or more screens (for example LED or OLED screens) spaced from the seated human occupant **HO**, and which partially or fully surround the seating system **300**, for example in the form of a
5 canopy or faceted wall around the seating system **300**.

In at least this example, the seating system **300** further comprises a manual control **396** actuable by the human occupant **HO** when the human occupant **HO** is accommodated in the seating system **300**. Such a manual control **396** is operatively connected to the controller **900**. The manual control **396** is configured for enabling the human occupant **HO**
10 to define the flight conditions being simulated by the flight simulation system **100**, by manipulating the manual control **396**, for example in a similar manner to a real aircraft. The manual control **396** is configured for providing control signals to the controller **900** to thereby cause the seating system **300** to provide a corresponding physical flight simulation to the human occupant **HO** corresponding to the predetermined g-forces and to the
15 respective aircraft control moments responsive to manual manipulation of the manual control **396** by the human occupant **HO**.

In at least this example, the manual control **396** is in the form of a joystick **395**, for example similar to the joystick of a real aircraft. For example, the joystick can be located in-between the legs of the human occupant **HO**, as illustrated in Fig. 1 for example, or on one
20 side of the human occupant **HO**, for example coupled to one of the armrests or to another part of the seat or cockpit mock-up. In alternative variations of this example, the joystick can be replaced with any suitable yoke that can be configured to appear, feel and operate in a similar manner to that of an aircraft that is being simulated.

Thus, the joystick **395**, operatively connected to the controller **900**, operates to relay
25 to the controller **900** control inputs from the human occupant **HO** regarding the real flight conditions **RFC** that the human occupant **HO** wishes to have simulated by the flight simulation system **100**.

Thus, the human occupant **HO** can manipulate the joystick **395** to virtually execute any desired flight maneuver in terms of acceleration, deceleration, climb, dive, turning in
30 pitch, roll and/or yaw, and so on. The controller **900** receives the aforesaid control inputs from the joystick **395** and in turn sends control outputs to the seating system **300** to provide

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physical simulation to the human occupant **HO** corresponding to these flight conditions, and concurrently, the panoramic display **470** provides a corresponding virtual visual display of the external environment consistent with such flight maneuvers.

For example, the operation of the joystick **395** can be of use in the training of a
5 human occupant **HO** having the role of a pilot.

However, in alternative variations of at least this example, the joystick **395** can be omitted or disconnected or not used, and the physically simulated flight conditions **PFC** are provided in a different manner. For example, a number of different sets of control outputs corresponding to a number of different physically simulated flight conditions **PFC** are
10 included in a memory of the controller **900**, and the controller **900** can be preset, or activated externally, to implement one or more such physically simulated flight conditions **PFC** by transmitting the respective outputs as provided by the memory. Additionally or alternatively, an external human controller can control operation of the controller **900** by inputting in real time control inputs corresponding to desired physically simulated flight conditions **PFC**, for
15 example by using an external joystick operatively coupled to the controller **900**. For example, such an external joystick can be operated by a human operator that is not accommodated in the seating system **300**. In such cases, the human occupant **HO** of the seating system **300** can have a non-pilot role, for example navigator, passenger, weapons specialist, and so on.

20 It is to be noted that in at least some alternative variations of this example, the seat **320** of the seating system can instead be incorporated in a cockpit mock-up or the like, and the rotary motion inducing structure is coupled to the cockpit mock-up. In such cases the display can be coupled to the cockpit window(s), for example.

As mentioned above, while the predetermined real flight conditions **RFC** include at
25 least real g-forces, the physically simulated flight conditions **PFC** include at least application of non-g forces to the human occupant **HO** corresponding to said g-forces.

By "non-g forces" is meant mechanical forces that are not gravitational or centrifugal in origin, and thus exclude mechanical forces that can be generated on a human subject using a centrifuge or the like.

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Thus, such non-g forces include mechanical forces that can be applied, for example to the human occupant **HO** when accommodated in the seating system **300**, via physical contact in a load-bearing manner between the respective force applicator and the human occupant **HO**.

5 In at least this example, the seating system **300** comprises a respective force applicator in the form of a mechanical force application system **700** configured for applying the aforesaid non-g forces to the human occupant **HO** corresponding to the real g-forces being simulated by the flight simulation system **100**.

In particular, mechanical force application system **700** is configured for applying the
10 aforesaid non-g forces to desired body portions of the human occupant **HO**. For example, such body portions can include at least one of: the arms; the legs; the shoulders; the abdomen; the head; the chest; the neck.

Referring to Fig. 2(a) and Fig. 2(b), a first example of the mechanical force application system **700** comprises a harness including a plurality of belts **710** and a
15 tensioning device **750**.

It is to be noted that the belts **710** are different from the regular seatbelts (not shown) that can optionally be used with the seating system **300**. Such seatbelts are typically used in the real aircraft for securing the human occupant to the seat.

The belts **710** are configured for being peripherally wound around respective body
20 portions of the human occupant **HO** when seated with respect to the seating system **300**. The belts **710** are coupled to the tensioning device **750**, and the tensioning device is operatively coupled to the controller **900**.

The tensioning device **750** is configured for selectively tightening or loosening a respective abutment contact between each respective belt **710** and the respective body
25 portion of the human occupant, responsive to receiving appropriate command signals from the controller **900**, such as to respectively increase or decrease a magnitude of said non-g forces applied via the belts **710** to the respective body portion of the human occupant **HO** corresponding to predetermined g-forces being simulated by the mechanical force application system **700**.

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For example, the tensioning device **750** comprises a plurality of motors, each motor being configured for turning a pulley or the like on which an end of a respective belt **710** is wound. The other end of each belt is anchored to a suitable location on the seat **320**. As the particular motor is selectively turned clockwise or counterclockwise, the belt is further
5 wound or unwound, respectively, with respect to the pulley, thereby tightening or untightening with respect to the respective body part of the human occupant **HO**. In this manner, the human occupant **HO** can be made to experience non-g mechanical forces on different parts of the body, consistent with the type of maneuver and g-forces being simulated by the flight simulation system **100** in real time.

10 For example, the belts **710** can include one or more of the following:

- shoulder belts provided over the shoulders;
- chest belts provided over the chest and lungs;
- abdominal belts provided over the abdomen;
- arm belts provided over the arms, for example the forearms;
- 15 - leg belts provided over the legs, for example the lower legs and/or the upper legs.

Special arrangements can be provided for the neck area such as to provide a mechanical force to the neck area while not strangulating the human occupant **HO**. For example, a U-shaped neck brace can be provided having a pressure-application component configured for selectively applying pressure to the carotid arteries to thereby diminish blood
20 flow to the brain, as controlled by controller **900**.

Referring to Fig. 3(a) and Fig. 3(b), a second example of the mechanical force application system **700** comprises a plurality of inflatable members **730** coupled to an inflation device **760**. While in this example the inflatable members **730** can be inflated pneumatically by the inflation device **760**, in alternative variations of this example, the
25 inflation device is configured for hydraulically inflating the inflatable members.

The inflatable members **730** are configured for being peripherally wound around respective body portions of the human occupant **HO** when seated with respect to the seating system **300**. For example each inflatable member **730** is in the form of a sleeve that includes

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a lumen which accommodates the respective body part. The inflatable members **730** are each coupled to the inflation device **760**, which is in turn operatively coupled to the controller **900**. The inflation device **760** is configured for selectively inflating or deflating the respective inflatable members **730** individually to respectively increase or decrease a
5 respective abutment pressure between each respective inflatable member **730** and the respective body portion of the human occupant **HO**. In this manner, it is possible to respectively increase or decrease a magnitude of the respective non-g forces applied by the inflatable members **730** to the respective body portion of the human occupant **HO** corresponding to predetermined g-forces being simulated by the system **100**.

10 For example, inflatable members **730** can include one or more of the following:

- inflatable members provided over the shoulders;
- inflatable members provided over the chest and lungs;
- inflatable members provided over the abdomen;
- inflatable members provided over the arms, for example the forearms;
- 15 - inflatable members provided over the legs, for example the lower legs and/or the upper legs.

Also in this example, special arrangements can be provided for the neck area such as to provide a mechanical force to the neck area while not strangulating the human occupant **HO**. For example, a U-shaped neck brace can be provided having a pressure-application
20 component configured for selectively applying pressure to the carotid arteries to thereby diminish blood flow to the brain, as controlled by controller **900**.

Referring again to Fig. 1, the sensor arrangement **500** is configured for providing real-time feedback data of predetermined physiological parameters **PPP** of the human occupant **HO**, in operation of the flight simulation system **100** with the human occupant **HO**
25 accommodated in the seating system **300**, wherein the predetermined physiological parameters **PPP** are indicative of the aforesaid g-force induced physiological stress.

In at least some examples, the sensor arrangement **500** includes one or more of the following:

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- an EMG sensor **510** configured for determining an electromyography (EMG) parameter **P1** of the human occupant **HO**;
- a pneumograph sensor **520** configured for determining a pneumograph parameter **P2** of the human occupant **HO**;
- 5 - a brain blood oxygenation level sensor **530** configured for determining a brain blood oxygenation level parameter **P3** of the human occupant **HO**.

For example, such EMG sensors **510** can be provided on the muscles for example of the arms and/or legs of the human occupant, and for example the results for each such sensor can be recorded separately.

- 10 For example, such pneumograph sensor **520** can be coupled to the lungs of the human occupant, for example via a breathing mask.

For example, such brain blood oxygenation level sensor **530** can be in for example the form of a blood saturation non-invasive sensor, and for example coupled to suitable blood vessels, for example on parts of the head or neck of the human occupant.

- 15 For example, the EMG parameter **P1** can be in the form of a variation of measured microvolts (μV) with time.

For example, the pneumograph parameter **P2** can be in the form of a variation of volume flow (for example liters/sec) with time, or volume (for example liters) with time.

- 20 For example, the brain blood oxygenation level parameter **P3** can be in the form of a variation of micro Moles (μMol) of hemoglobin with time, in particular micro Moles (μMol) of oxygenated hemoglobin with time.

- Referring again to Fig. 1, in at least this example, the flight simulation system **100** optionally further comprises an auxiliary display device **800** coupled to the controller **900** and to the sensor system **500**. The auxiliary display device **800** is configured for displaying
25 to the human occupant **HO** at least the aforesaid real-time feedback data of one or more of the aforesaid predetermined physiological parameters **PPP**, in particular regarding one or more of the EMG parameter **P1**, the pneumograph parameter **P2**, and the brain blood oxygenation level parameter **P3** of the human occupant **HO**.

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The auxiliary display device **800** can also be configured for concurrently showing the variation of simulated g-forces with time.

It is to be noted that in some examples the auxiliary display device **800** and the visual display device **470** can be separate components. For example, in examples in which the visual display device **470** is not physically connected to the human occupant, for example where the respective seating system **300** is accommodated in a cockpit mock-up or the like, wherein the visual display device **470** is provided on the cockpit windows or outside thereof, the auxiliary display device **800** can be accommodated within the cockpit mock up, within view of the human occupant **HO**, for example as part of the instrument panel.

However, in other examples the auxiliary display device **800** can be integrated with the visual display device **470**, for example, the functions of the auxiliary display device **800** and the visual display device **470** can be provided in a single integrated display. For example, in examples in which the visual display device **470** is directly connected to the human occupant **HO**, for example in the form of virtual reality goggles **472**, the auxiliary display device **800** can be in the form of a virtual auxiliary display device or in the form of a virtual auxiliary display, which can be selectively introduced in the field of view of the human occupant **HO** via the goggles.

Optionally, a second auxiliary display device can be provided for an external user, for example a test supervisor, to enable the external user to monitor at least the aforesaid real-time feedback data of the aforesaid predetermined physiological parameters.

As will become clearer herein, the auxiliary display device **800** provides a visual indication of how the one or more physiological parameters **PPP** are varying in real time during a particular simulated flight maneuver, and can further provide an indication as to how effectively the human occupant **HO** may be countering the physiological effects, if any. For example, during a training session using the flight simulation system **100**, a number of anti-g straining maneuvers (AGSM) can be applied by the human occupant **HO**, and the auxiliary display device **800** can function to provide an indication as to how the AGSM are affecting the physiological parameters **PPP**. This can enable the human occupant **HO** to determine in real time how effective the applied AGSM are, and to aid the human occupant **HO** in further improving the implementation of the AGSM to provide even more effective

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response to the physiological effects to the non-g forces in physically simulated flight conditions **PFC** that closely resemble the real flight conditions **RFC**.

As an aid to the human occupant **HO**, especially for the flight training thereof, and referring to Fig. 4, the auxiliary display device **800** is configured for comparing the real-time
5 feedback data of the physiological parameters **PPP** with first datum feedback data representative of respective first threshold levels **PPP-T1** of the predetermined physiological parameters **PPP**.

The first threshold levels **PPP-T1** are considered to be representative of safe levels for the predetermined physiological parameters **PPP**, at least sufficient for avoiding onset of
10 g-force induced loss of consciousness.

Thus, during for example a training session for the human occupant, so long as the various predetermined physiological parameters **PPP** remain within the respective first threshold levels **PPP-T1**, there is no need for the human occupant **HO** to take any action to counter the physiological effects relating to the predetermined physiological parameters
15 **PPP**.

For example, the first threshold levels **PPP-T1** can correspond to conditions consistent with the application of g-forces in the range 1g to 1.5g to a human body.

As a further aid to the human occupant **HO**, especially for the flight training thereof, the auxiliary display device **800** can also be configured for alerting the human occupant **HO**
20 responsive to the real-time feedback data of the predetermined physiological parameters **PPP** approaching or exceeding a second datum feedback data representative of respective second threshold levels **PPP-T2** of the predetermined physiological parameters **PPP**. Such an alert can take the form of, for example, warning lights and/or warning messages being displayed by the auxiliary display device **800**, and/or, audio warning signals.

25 The second threshold levels **PPP-T2** are considered to be representative of minimum unsafe levels for the predetermined physiological parameters **PPP** corresponding to onset of g-force induced loss of consciousness (g-loc).

As a further aid to the human occupant **HO**, especially for the flight training thereof, the auxiliary display device **800** is configured for optionally prompting the human occupant

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HO to initiate anti-g straining maneuvers (AGSM) for managing levels of the predetermined physiological parameters **PPP** at least when the second threshold level **PPP-T2** is being approached or exceeded, and for reducing said levels of the predetermined physiological parameters **PPP** to said first threshold level **PPP-TS1**.

5 For example, the AGSM can comprise application of muscle tension procedures to predetermined muscle groups by the human occupant. Such muscle can include, for example, muscles in the abdomen and extremities of the human occupant **HO**.

For example, one type of AGSM can be in the form of the human occupant **HO** applying rapid static contractions of muscles in at least one of the arms, legs and abdomen.

10 Furthermore, for example, another type of AGSM can be in the form of the human occupant **HO** applying specialized breathing cycle configured to maintain air pressure in the lungs.

The flight simulation system **100** can be operated, for example for training a human occupant **HO** to become accustomed to and/or to apply for example AGSM to counter g-
15 force induced physiological stress to the human occupant **HO**, for example according to at least a first example of a training method, generally designated with reference numeral **1000**.

Referring to Fig. 5, the training method **1000** comprises the following steps:

Step **1100** ~ providing a flight simulation system, for example the flight simulation system **100** as disclosed herein.

20 Step **1200** ~ accommodating a human occupant **HO** in the flight simulation system **100**, in particular in the seating system **300** thereof.

Step **1300** ~ choosing at least one real flight condition **RFC** to be simulated by the flight simulation system **100**.

25 Step **1400** ~ causing the controller **900** to provide to the human occupant **HO** a physical simulated flight condition **PFC** corresponding to the real flight condition **RFC** of step **1300**, said physical simulated flight condition **PFC** including corresponding physically simulated non-g forces and optionally corresponding physically simulated respective aircraft control moments.

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Thus, with the human occupant **HO** accommodated in the seating system **300**, the flight simulation system **100** is operated to provide a physical simulation of any desired real flight conditions, either by manipulation of the joystick **395** by the human occupant **HO**, or by implementing simulated flight conditions from the memory of the controller **900**, or by controlling operation of the controller by an external user, for example.

Such real flight conditions **RFC** can include, for example, any type of real flight maneuvers that are likely to be encountered by the human occupant **HO** when flying or when being flown in a real aircraft, and in particular wherein the real flight conditions of such maneuvers include g-forces that are considered to be sufficient to provide g-force induced physiological stress to the human occupant **HO**. For example, such real flight conditions **RFC** can include evasive maneuvers, dog fight maneuvers, diving maneuvers, climbing maneuvers, and so on. The flight simulation system **100** can provide to the human occupant **HO** the physical application of non-g forces generated by the seating system **300** (corresponding to the real g-forces that are being stimulated by the flight simulation system **100**), to enable the human occupant **HO** to physically experience mechanical forces on the body in a similar manner to what the human occupant **HO** would experience in such real-life flight conditions.

In the first place, such a use of the flight simulation system **100** can be used for preparing the human occupant **HO** as to what to physically expect when flying or being flown in a real aircraft, wherein g-forces can change rapidly, and can be coupled with changes in orientation such as via roll, pitch and/or yaw.

For example, the real flight conditions **RFC** of step **1300** can include g-forces within a range 0 to 9g, and step **1400** comprises the step of operating the seating system **300** to cause application to the human occupant **HO** of physically simulated non-g forces via the mechanical force application system **700**, corresponding to the g-forces corresponding to the real flight condition **RFC** of step **1300**.

Furthermore, and in the second place, the flight simulation system **100** can also be used for physically simulating to the human occupant **HO** other flight scenarios, such as for example ejection seat operation, in which the seated human occupant **HO** is expected to experience very high g-forces, typically in tens of g's – for example about 35g – but only for a very short duration, in the order of milliseconds. The human occupant

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HO can be subjected, via the flight simulation system **100**, to non-g forces corresponding to such high g-loads, and for a comparable short duration.

Furthermore, the method **1000** for using the flight simulation system **100** can further comprise providing real-time feedback data of said predetermined physiological parameters **PPP** of the human occupant **HO** at the physically simulated flight conditions **PFC**, for example via the auxiliary display device **800**.

Thus, as a particular real flight condition **RFC** including g maneuvers is being simulated by the flight simulation system **100**, and the seating system **300** is applying to the human occupant **HO** corresponding non-g forces to various body portions of the human occupant **HO**, the auxiliary display device **800** can display in real time the corresponding levels of the predetermined physiological parameters **PPP** – in particular of the EMG parameter **P1**, and/or of the pneumograph parameter **P2**, and/or of the brain blood oxygenation level parameter **P3**.

These levels can be monitored against the respective first threshold level **PPP-T1** and the respective second threshold level **PPP-T2**, which can also be concurrently displayed by the auxiliary display device **800**.

The method **1000** can then be expanded to enable the human occupant **HO** to train as to how to resist the physiological effects of high g-forces, and includes the step **1500** wherein the human occupant **HO** initiates anti-g straining maneuvers (AGSM) for training to manage levels of the predetermined physiological parameters **PPP**, responsive to application of non-g forces to the human occupant **HO**.

Referring to Fig. 6, training step **1500** can include the following sub-steps:

- Step **1500a** ~ setting the real flight conditions **RFC** to correspond to a minimum g-force at or greater than 1g;
- Step **1500b** ~ providing real-time feedback data of predetermined physiological parameters **PPP** of the human occupant **HO** at the real flight conditions **RFC** of step **1500a**;
- Step **1500c** ~ the human occupant **HO** initiates anti-g straining maneuvers (AGSM) for managing levels of the one or more predetermined physiological parameters **PPP** responsive to application of the corresponding non-g forces

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to the human occupant **HO** (via the seating system **300**) corresponding to the real g-forces being simulated;

Step **1500d** ~ providing real-time feedback data of predetermined physiological parameters **PPP** of the human occupant **HO** at the flight conditions of step **1500c**;

Step **1500e** ~ setting the real flight conditions to correspond to an increment in the g-force, for example by manipulation of the joystick **395** by the human occupant **HO**, or by implementing simulated flight conditions from the memory of the controller **900**, or by controlling operation of the controller by an external user;

Step **1500f** ~ repeating steps Step **1500e** and Step **1500d** at the increased g-force of step **1500e**;

Step **1500g** ~ checking whether the increased g-force of step **1500e** exceeds predetermined safety limits, wherein:

- if the increased g-force of Step **1500e** exceeds predetermined safety limits for example corresponding to the second threshold **PPP-T2**, terminate the said flight simulation; or
- if the increased g-force of Step **1500e** does not exceed said predetermined safety limits, then repeating Step **1500e** to Step **1500g**.

For example, the minimum g-force in sub-step **1500a** can be 1g or 1.5g, and the increment in the g-force in step **1500e** can be 0.5g, for example.

For example, the predetermined safety limits in step **1500g** can correspond to a g-force of 9g in cases where flight maneuvers per se are being simulated, while in simulation of ejection seat scenarios the predetermined safety limits in step **1500g** can correspond to a g-force of 35g.

In step **1500c**, the AGSM can include the human occupant **HO** applying muscle tension procedures to predetermined muscle groups, for example muscles in the abdomen and extremities of the human occupant **HO**. Furthermore, the step of initiating the AGSM includes the human occupant **HO** applying rapid static contractions of muscles in the arms, legs and abdomen, for example.

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As the human occupant **HO** is progressing with such muscle tension procedures, thereby resisting or attempting to resist the applied non-g forces, the human occupant **HO** can observe via the auxiliary display device **800** the effects of the muscle tension procedures in real time, for example by way of how the levels of the predetermined physiological parameters **PPP** are changing. Thus, the human occupant **HO** obtains immediate feedback of how effective the muscle tension procedures are in each of the flight conditions being simulated by the flight simulation system **100**, and enables the human occupant **HO** to further improve resistance to the applied non-g forces.

In step **1500c**, the AGSM can additionally or alternatively include the human occupant **HO** applying specialized breathing cycle configured to maintain air pressure in the lungs. For example, such specialized breathing cycles are well known in the art.

As the human occupant **HO** is progressing with such specialized breathing cycles, thereby resisting or attempting to resist the applied non-g forces, the human occupant **HO** can observe on the auxiliary display device **800** the effects of the specialized breathing cycles in real time, by way of how the levels of the predetermined physiological parameters **PPP** are changing. Thus, the human occupant **HO** obtains immediate feedback of how effective the specialized breathing cycles are in each of the flight conditions being simulated by the flight simulation system **100**, and enables the human occupant **HO** to further improve resistance to the applied non-g forces.

Thus, in execution of step **1500**, the sensor arrangement **500** operates to provide levels of the EMG parameter **P1** of the human occupant, and/or of the pneumograph parameter **P2** of the human occupant, and/or of the brain blood oxygenation level parameter **P3** of the human occupant.

In the method claims that follow, alphanumeric characters and Roman numerals used to designate claim steps are provided for convenience only and do not imply any particular order of performing the steps.

Finally, it should be noted that the word “comprising” as used throughout the appended claims is to be interpreted to mean “including but not limited to”.

While there has been shown and disclosed examples in accordance with the presently disclosed subject matter, it will be appreciated that many changes may be made therein

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without departing from the scope of the presently disclosed subject matter as set out in the claims.

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CLAIMS:

1. A flight simulation system for enabling g-force training, comprising
a seating system configured for accommodating a human occupant and for
providing to the human occupant physically simulated flight conditions
5 corresponding to predetermined real flight conditions, said predetermined real
flight conditions including g-forces, wherein said physically simulated flight
conditions include application of non-g forces to the human occupant
corresponding to said g-forces, and wherein said g-forces are considered sufficient
to provide g-force induced physiological stress to the human occupant;
10 a sensor arrangement configured for providing real-time feedback data of
predetermined physiological parameters of the human occupant, in operation of
the flight simulation system with the human occupant accommodated in the
seating system, wherein said predetermined physiological parameters are
indicative of said g-force induced physiological stress;
15 a controller configured for controlling the seating system to provide said
physically simulated flight conditions.
2. The flight simulation system according to claim 1, wherein said predetermined
real flight conditions include real control moments in pitch, yaw and roll, and wherein
20 said physically simulated flight conditions further include physically simulated control
moments in pitch, yaw and roll applied to the human occupant corresponding to said
respective real control moments in pitch, yaw and roll.
3. The flight simulation system according to any one of claims 1 to 2, wherein said
25 g-force induced physiological stress includes at least one of: breathing difficulties; blood
loss in the brain; reduced vision; tunnel vision; loss of vision; g-LOC/
4. The flight simulation system according to any one of claims 1 to 3, further
comprising a display device coupled to the controller and to the sensor system, the display
30 device being configured for displaying to the human occupant at least said real-time
feedback data.

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5. The flight simulation system according to claim 4, wherein the display device is configured for comparing said real-time feedback data with first datum feedback data representative of first threshold levels of said predetermined physiological parameters, wherein said first threshold levels are considered to be representative of safe levels for
5 said predetermined physiological parameters at least sufficient for avoiding onset of g-force induced loss of consciousness.

6. The flight simulation system according to any one of claims 4 to 5, wherein the display device is configured for alerting the human occupant responsive to said real-time
10 feedback data approaching or exceeding second datum feedback data representative of second threshold levels of said predetermined physiological parameters, wherein said second threshold levels are considered to be representative of minimum unsafe levels for said predetermined physiological parameters corresponding to onset of g-force induced loss of consciousness.

15

7. The flight simulation system according to claim 6, wherein the display device is configured for prompting the human occupant to initiate anti-g straining maneuvers (AGSM) for managing levels of said predetermined physiological parameters at least when said second threshold level is being approached or exceeded, and for reducing said
20 levels to said first threshold level.

8. The flight simulation system according to claim 7, wherein said AGSM comprises application of muscle tension procedures to predetermined muscle groups by the human occupant.

25

9. The flight simulation system according to claim 8, wherein said predetermined muscle groups include muscles in the abdomen and extremities of the human occupant.

10. The flight simulation system according to any one of claims 7 to 9, wherein said
30 AGSM comprises the human occupant applying rapid static contractions of muscles in at least one of the arms, legs and abdomen.

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11. The flight simulation system according to any one of claims 7 to 10, wherein said AGSM comprises the human occupant applying specialized breathing cycle configured to maintain air pressure in the lungs.

5 12. The flight simulation system according to any one of claims 1 to 11, wherein said sensor arrangement includes a sensor configured for determining an electromyography (EMG) parameter of the human occupant.

10 13. The flight simulation system according to any one of claims 1 to 12, wherein said sensor arrangement includes a sensor configured for determining a pneumograph parameter of the human occupant.

14. The flight simulation system according to any one of claims 1 to 13, wherein said sensor arrangement includes a sensor configured for determining a brain blood
15 oxygenation level parameter of the human occupant.

15. The flight simulation system according to any one of claims 1 to 14, wherein said seating system comprises a mechanical force application system configured for applying said non-g forces to the human occupant corresponding to said g-forces being simulated
20 by the system.

16. The flight simulation system according to claim 15, wherein said mechanical force application system comprises a plurality of belts configured for being peripherally wound around respective body portions of the human occupant when seated with respect to the
25 seating system, the belts being coupled to a tensioning device, the tensioning device being configured for selectively tightening or loosening a respective abutment contact between each respective said belt and the respective body portion of the human occupant, such as to respectively increase or decrease a magnitude of said non-g forces to the respective body portion of the human occupant corresponding to predetermined g-forces being
30 simulated by the system.

17. The flight simulation system according to claim 15, wherein said mechanical force application system comprises a plurality of inflatable members configured for being

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peripherally wound around respective body portions of the human occupant when seated with respect to the seating system, the inflatable members being coupled to an inflation device, the inflation device being configured for selectively inflating or deflating the respective inflatable members to respectively increase or decrease a respective abutment
5 pressure between each respective said inflatable member and the respective body portion of the human occupant, such as to respectively increase or decrease a magnitude of said non-g forces to the respective body portion of the human occupant corresponding to predetermined g-forces being simulated by the system.

10 **18.** The flight simulation system according to any one of claims 15 to 17, wherein said body portions include at least one of: the arms; the legs; the shoulders; the abdomen; the head; the chest; the neck.

19. The flight simulation system according to any one of claims 1 to 18, wherein the
15 seating system comprises a seat including a seat cushion and a backrest, the seat being coupled to a rotary motion inducing structure configured for selectively generating said simulated control moments in pitch, yaw and roll to the seat corresponding to said real control moments in pitch, yaw and roll.

20 **20.** The flight simulation system according to claim 19, wherein said rotary motion inducing structure comprises a movable frame pivotably mounted to a base structure, wherein the seat is pivotably mounted to the movable frame, such as to enable the seat to be pivoted with respect to the base structure in one, two or three degrees of freedom, and wherein said rotary motion inducing structure comprises a driving system for selectively
25 pivoting the seat with respect to the base structure in said one, two or three degrees of freedom, to provide said control moments in pitch, yaw and roll to the seat responsive to receiving actuation command from the controller corresponding to said predetermined respective aircraft control moments being simulated by the flight simulation system.

30 **21.** The flight simulation system according to claim 19, wherein the seat is mounted in a cockpit mock-up, and wherein said rotary motion inducing structure comprises a movable frame pivotably mounted to a base structure, wherein the cockpit mock-up is pivotably mounted to the movable frame, such as to enable the seat to be pivoted with

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respect to the base structure in one, two or three degrees of freedom, and wherein said rotary motion inducing structure comprises a driving system for selectively pivoting the cockpit mock-up with respect to the base structure in said one, two or three degrees of freedom, to provide said control moments in pitch, yaw and roll to the cockpit mock-up
5 responsive to receiving actuation command from the controller corresponding to said predetermined respective aircraft control moments being simulated by the flight simulation system.

22. The flight simulation system according to any one of claims 1 to 21, comprising
10 a visual display device configured for providing a visual display of a virtual simulation corresponding to said flight conditions from a subjective visual viewpoint of the human occupant when accommodated in said seating system.

23. The flight simulation system according to claim 22, wherein the visual display
15 device is in the form of virtual reality goggles.

24. The flight simulation system according to any one of claims 1 to 23, wherein the seating system comprises a manual control actuable by the human occupant when the human occupant is accommodated in the seating system, said manual control being
20 operatively connected to the controller, wherein the manual control is configured for enabling the human occupant to define the flight conditions being simulated by manipulating said manual control, and wherein the manual control is configured for providing control signals to the controller to thereby cause the seating system to provide a corresponding said physical flight simulation to the human occupant corresponding to
25 said predetermined g-forces and said predetermined respective aircraft control moments responsive to manual actuation of the manual control by the human occupant.

25. The flight simulation system according to claim 24, wherein said manual control is in the form of a joystick.
30

26. A method for enabling g-force training, comprising:
providing a flight simulation system as defined in any one of claims 1 to
25;

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accommodating a human occupant in the flight simulation system;
choosing a real flight condition to be simulated by the flight simulation
system;

causing the controller to provide to the human occupant a physical
5 simulated flight condition corresponding to said real flight condition, said
physical simulated flight condition including corresponding physically simulated
non-g forces.

27. The method according to claim 26, wherein said physical simulated flight
10 condition further includes corresponding physically simulated respective aircraft control
moments.

28. The method according to any one of claims 26 to 27, wherein said real flight
conditions include g-forces within a range 0 to 9g, and comprising the step of operating
15 said seating system to cause application to the human occupant of said physically
simulated g-forces in the form of respective non-g forces.

29. The method according to any one of claims 26 to 27, wherein said real flight
conditions include g-forces up to 35g, and comprising the step of operating said seating
20 system to cause application to the human occupant of said physically simulated g-forces
in the form of respective non-g forces.

30. The method according to any one of claims 26 to 29, comprising providing real-
time feedback data of said predetermined physiological parameters of the human
25 occupant at said physically simulated flight conditions.

31. The method according to any one of claims 26 to 30, comprising the step wherein
the human occupant initiates anti-g straining maneuvers (AGSM) for managing levels of
said predetermined physiological parameters responsive to application of said non-g
30 forces to the human occupant.

32. The method according to claim 31, comprising the following steps:

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- (a) setting said real flight conditions to correspond to a minimum g-force greater than 1g;
 - (b) providing real-time feedback data of predetermined physiological parameters of the human occupant at the real flight conditions of step (a);
 - 5 (c) the human occupant initiates anti-g straining maneuvers (AGSM) for managing levels of said predetermined physiological parameters responsive to application of said non-g forces to the human occupant corresponding to said g-force;
 - (d) providing real-time feedback data of predetermined physiological parameters of the human occupant at the flight conditions of step (c);
 - 10 (e) setting said real flight conditions to correspond to an increment in said g-force;
 - (f) repeating steps (c) and (d) at the increased g-force of step (e);
 - (g) checking whether the increased g-force of step (e) exceeds predetermined safety limits, wherein:
 - if the increased g-force of step (e) exceeds predetermined safety limits,
 - 15 terminate the said flight simulation; or
 - if the increased g-force of step (e) does not exceed said predetermined safety limits repeating steps (e) to (g).
- 20 **33.** The method according to claim 32, wherein said minimum g-force is 1.5g.
- 34.** The method according to any one of claims 32 to 33, wherein said increment in said g-force is 0.5g.
- 25 **35.** The method according to any one of claims 32 to 34, wherein said predetermined safety limits corresponds to a g-force of 9g.
- 36.** The method according to any one of claims 32 to 34, wherein said predetermined safety limits corresponds to a g-force of 35g.
- 30 **37.** The method according to any one of claims 32 to 36, wherein said step of initiating said AGSM comprises the human occupant applying muscle tension procedures to predetermined muscle groups.

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38. The method according to claim 37, wherein said predetermined muscle groups include muscles in the abdomen and extremities of the human occupant.

39. The method according to any one of claims 32 to 38, wherein said step of initiating
5 said AGSM comprises the human occupant applying rapid static contractions of muscles in the arms, legs and abdomen.

40. The method according to any one of claims 32 to 39, wherein said step of initiating
said AGSM comprises the human occupant applying specialized breathing cycle
10 configured to maintain air pressure in the lungs.

41. The method according to any one of claims 26 to 40, wherein said sensor
arrangement operates to provide an electromyography (EMG) parameter of the human
occupant.
15

42. The method according to any one of claims 26 to 41, wherein said sensor
arrangement operates to provide a pneumograph parameter of the human occupant.

43. The method according to any one of claims 26 to 42, wherein said sensor
20 arrangement operates to provide a brain blood oxygenation level parameter of the human
occupant.

44. The method according to any one of claims 26 to 43, wherein said real flight
conditions include any one of: evasive maneuvers, dog fight maneuvers, diving
25 maneuvers.