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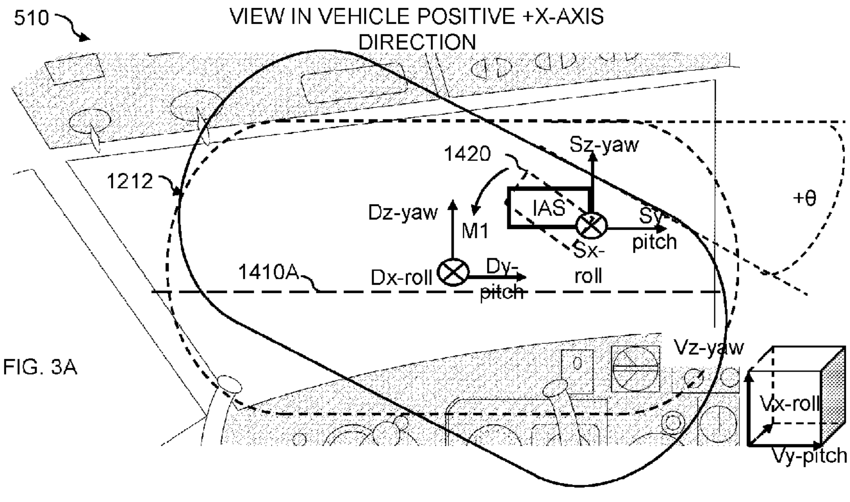

FIG. 3A

(57) Abstract: Embodiments concern a method for providing information to a user of a vehicle via a display device that is worn by the user. The method comprises providing a principle axes rotation coordinate system (V_{xyz}) that defines a vehicle orientation relative to a world coordinate system (W_{xyz}) of a reference world space; providing at least one display device coordinate system (D_{xyz}) that defines a display device orientation relative to the vehicle coordinate system; and providing a symbol coordinate system (S_{xyz}) that is spatially fixed with at least one first symbol to be displayed on the display device and that defines three symbol rotation axes that are orthogonal to each other; and spatially fixing at least one of the symbol rotation axes (S_{α}) to a vehicle principal axis of rotation descriptive of an orientation of the vehicle.

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HEAD MOUNTED DISPLAY DEVICE, SYSTEM AND METHOD

TECHNICAL FIELD

[0001] The present disclosure relates in general to display devices, systems and methods and, more particularly, to head-mounted display devices, systems and methods.

BACKGROUND

[0002] Head-mounted displays (HMDs), which also include Helmet-mounted displays are, *inter alia*, employed for conveying information to a user controlling a vehicle and/or for monitoring parameters relating to the vehicle's operation. HMDs can be configured to display a computer-generated symbol while at same time allowing the user to see through the HMD's visor. Exemplarily, HMDs can facilitate the piloting of an aircraft by displaying to the user (also: pilot) a variety of information including, for example, the aircraft's pitch (also: elevation), yaw (also: azimuth), roll, velocity relative to ground, height and drift.

[0003] Under certain circumstances, the user's ability to control a vehicle may become compromised due to sensory mismatch between the sensations felt in the inner ear vestibular system and those experienced through other senses, such as the user's visual perceptions. Examples of sensory mismatch include motion sickness and spatial disorientation such as vertigo.

[0004] The description above is presented as a general overview of related art in this field and should not be construed as an admission that any of the information it contains constitutes prior art against the present patent application.

BRIEF DESCRIPTION OF THE FIGURES

[0005] The figures illustrate generally, by way of example, but not by way of limitation, various embodiments discussed in the present document.

[0006] For simplicity and clarity of illustration, elements shown in the figures have not necessarily been drawn to scale. For example, the dimensions of some of the elements may be exaggerated relative to other elements for clarity of presentation. Furthermore, reference numerals may be repeated among the figures to indicate corresponding or analogous elements. References to previously presented elements are implied without necessarily further citing the drawing or description in which they appear. The figures are listed below.

[0007] **FIG. 1A** is a schematic illustration of the principal axes of rotation of an aircraft;

[0008] **FIG. 1B** is a schematic illustration of the axes of rotation of a pilot's head or of a display device while worn by the pilot, and of a symbol displayed to the pilot using the display device, according to some embodiments;

[0009] **FIGs. 2A** and **2B** are schematic illustrations of symbol orientation relative to the orientation of the display device and control station of the aircraft;

[0010] **FIGs. 3A** and **3B** are schematic illustrations of symbol orientation relative to the orientation of display device and the aircraft, according to some embodiments;

[0011] **FIG. 4** is a block diagram illustration of a gaze tracking and display (GTAD) system, according to some embodiments;

[0012] **FIG. 5A** is a schematic illustration of a non-conformal symbol and of a symbol representing a vehicle state vector as viewed on a display area of the display device, according to some embodiments;

[0013] **FIG. 5B** is a block diagram illustration of the type or classes of symbols that are displayable using the display device;

[0014] **FIGs**. **5C** and **5D** schematically illustrate an example of a partially conformal symbol and a partially conformal change in the display thereof, according to some embodiments;

[0015] **FIGs**. **6A** and **6B** schematically illustrate a symbol orientation relative to the display device and the aircraft when all rotation axes are aligned with each other;

[0016] **FIGs**. **7A** and **7B** schematically illustrate a position of the symbol after traversing the display device in a positive yaw direction relative to the situation shown in **FIGs. 6A** and **6B**, according to some embodiments;

[0017] **FIGs**. **8A** and **8B** schematically illustrate a position of the symbol after traversing the display device in a negative pitch direction relative to the situation shown in **FIGs. 6A** and **6B**, according to some embodiments;

[0018] **FIGs**. **9A** and **9B** schematically illustrate a position of the symbol after traversing the display device in a positive roll direction relative to the situation shown in **FIGs. 8A** and **8B**, according to some embodiments;

[0019] **FIGs**. **10A** and **10B** schematically illustrate a position of the symbol after traversing the display device both in a positive roll and negative pitch direction relative to the situation shown in **FIGs. 8A** and **8B**, according to some embodiments;

[0020] **FIG. 11** is a schematic illustration of a remote control GTAD system, according to a first embodiment;

[0021] **FIG. 12** is a schematic illustration of a remote control GTAD system, according to a second embodiment;

[0022] **FIG. 13** is a flow chart illustration of a method for displaying symbol by a head-mounted display (HMD) device, according to some embodiments;

[0023] **FIG. 14A** is a schematic side-view illustration of the regions of a total field of view (TFOV), according to some embodiments;

[0024] **FIG. 14B** is a schematic rear-view illustration of the regions of the TFOV, according to some embodiments;

[0025] **FIG. 15** is a schematic illustration of viewing regions of an aircraft cockpit, according to some embodiments;

[0026] **FIGs. 16A to 17D** are schematic illustrations of the display of a symbol to the pilot when gazing towards one of the various viewing regions, according to some embodiments;

[0027] **FIGs. 18A** and **18B** are schematic illustration of a regular and ghosted display mode of a vehicle state vector, according to some embodiments;

[0028] **FIG. 18C** is a schematic illustration of displaying a non-conformal symbol in accordance with a position of a vehicle state vector displayed on the display area, according to some embodiments;

[0029] **FIGs. 19** to **22** are schematic illustrations of actionably acquiring and engaging real-world objects, according to some embodiments;

[0030] **FIG. 23** is a flowchart of a method for generating and displaying to the pilot a symbol that is operatively associated with a real-world control object, according to some embodiments;

[0031] **FIGs. 24A** and **24B** are schematic illustrations of controlling a vehicle operation, according to some embodiments; and

[0032] **FIG. 25** is a flowchart of a method of controlling vehicle operation functions, according to some embodiments.

DETAILED DESCRIPTION

[0033] Embodiments disclosed herein relate to devices, systems and methods for displaying information to a user and which may be configured to facilitate the monitoring and/or controlling of a vehicle, for example, by alleviating or preventing sensory mismatch between the sensations felt in the inner ear vestibular system and those experienced through other senses, and/or by improving ergonomics.

[0034] The following description of the display devices, systems and methods is given with reference to particular examples, with the understanding that such devices, systems and methods are not limited to these examples.

[0035] Referring now to **FIGs. 1A** and **1B**, a current or present orientation of an object (e.g., a rigid body and/or of a graphical symbol) with respect to a fixed or reference coordinate system (CS) may be expressed by attitude or orientation angles formed by the object's principal axes of rotation (also: principal axes) relative to the reference coordinate system. In order to determine the orientation of an object relative to a reference coordinate system, the object's principal axes are transformed into the reference coordinate system by using the Euler angles. The Euler angles are thus the angles through which the object's coordinate system must be rotated to bring its axes to coincidence with the reference coordinate system. Accordingly, the Euler angles describe the object's roll (also: bank), pitch (also: elevation), and azimuth (also: heading) orientation with respect to the reference coordinate system. Hence, one can define the orientation of an object relative to a reference coordinate system by the amount of rotation of the parts of the object about these principal axes.

[0036] Optionally, yaw, pitch and roll may refer to deviations from a nominal attitude or orientation.

[0037] In the accompanying figures, principal axes of rotation may be schematically illustrated as broken arrows.

[0038] In the discussion herein, the following conventions are used: the **X-axis** is defined as the roll axis; the **Y-axis** is defined as the pitch axis; and the **Z-axis** is defined as the yaw axis. A positive rotation direction is defined by the so-called "right-hand rule" and **θ := x-roll angle**; **ϕ := y-pitch angle**; and **ψ := z-yaw angle/azimuth**.

[0039] The terms "Euler angle", "orientation", "attitude", "angular orientation", "angle", as well as grammatical variations thereof and/or analogous expressions, may herein be used interchangeably.

[0040] It should be noted that while the rotation coordinate systems are herein exemplified as Cartesian coordinate systems in which the axes are perpendicular to each other, this should by no means be construed as limiting.

[0041] Vehicle CS $\mathbf{V}_{xyz}$ shown in **FIG. 1A** is a Cartesian representation of the principal axes of rotation of a vehicle **500** (herein exemplified by an aircraft) that is located in a reference world space **10**, which can be a physical or real reference world space, or a virtual (e.g., computer-generated) reference world space. A physical reference world space is different from a virtual reference world space in that the physical reference world space actually comprises a control station **510**, whereas the virtual reference world space may be used in a simulation environment and simulates or emulates that control station **510** is located within a selected reference world space. The virtual reference world space can be different from the physical space in which control station **510** is located in reality. In either case, $\mathbf{V}_{xyz}$ is spatially fixed to vehicle **500**, so that an attitude of vehicle **500** may be expressed by the angles of the vehicle CS $\mathbf{V}_{xyz}$ relative to a world coordinate system (**Wxyz**) of reference world space **10**.

[0042] Non-limiting examples of control station **510** can include a cockpit (e.g., of a passenger plane, a combat aircraft, a vertical takeoff and landing (VTOL) aircraft, a tiltrotor aircraft, a transport aircraft, a fixed-wing aircraft, a rotary-wing aircraft, and/or a combined fixed/rotary-wing aircraft); a bridge of a watercraft (e.g., a passenger ship, a frigate, an aircraft carrier, a freighter); a driver cabin (e.g., of a car, bus, truck and/or armored fighting vehicle); a submarine control/command room; a vehicle control simulator (e.g., a flight simulator, a passenger car driving simulator); and/or any other vehicle command or control room, e.g., including for remote controlling of a vehicle, as outlined herein below in more detail.

[0043] While the embodiments disclosed herein may relate to aircrafts, this should by no means be construed limiting. Accordingly, embodiments disclosed herein may additionally or alternatively be employed in conjunction with vehicles including, for example, land-based vehicles such as, for instance, a passenger car, a motorcycle, a bicycle, a transport vehicle (e.g., a bus, truck, a rail-based transport vehicle, etc.), a watercraft, a submarine, a spaceship, a multipurpose vehicle such as a hovercraft, and/or the like.

[0044] To simplify the discussion that follows, without be construed limiting, "vehicle **500**" may herein be referred to as aircraft **500**, and "control station **510**" may herein be referred to as "cockpit **510**". Accordingly, where reference is made to an "aircraft", the corresponding description may be analogously or equally applicable to "vehicles" in general. In some embodiments, a control station may embody a remote control station for remotely controlling (e.g., piloting) a vehicle.

[0045] As shown schematically in **FIG. 1B**, a display device **1200** such as an HMD may be worn by a user (e.g., pilot) **600**. Without be construed limiting, a "user" may herein also be referred to as a "pilot" of aircraft **500**; and a "display device" may herein also be referred to as "HMD". Optionally, an HMD may be embodied by glasses and/or goggles (e.g., including night vision goggles) which are mounted on a helmet. Optionally, an HMD may comprise glasses and/or goggles.

[0046] Display device **1200** is configured to display information to pilot **600** to facilitate the piloting of aircraft **500**. An orientation of display device **1200** relative to the vehicle coordinate system **Vxyz** is herein exemplarily expressed by a display device or HMD coordinate system $\mathbf{D}_{\mathbf{x\text{-}roll,\ y\text{-}pitch,z\text{-}yaw}}$ ($\mathbf{D}_{\mathbf{xyz}}$) that is defined as being spatially fixed to display device **1200**. Optionally, display device coordinate system $\mathbf{D}_{\mathbf{xyz}}$ may be the principal axes of display device **1200**.

[0047] In an embodiment, both display device **1200** and user **600** can be carried by vehicle **500** and may be, for example, located in cockpit **510**. Optionally, display device **1200** may move freely within vehicle **500** and still be operationally usable by user **600**. Display device **1200** may for example move freely in cockpit **510**, a freight space, a deck of a ship and/or in any area or location of vehicle **500** while, at the same time, be operationally usable by user **600** wearing display device **1200** as exemplified herein.

[0048] Display device **1200** is configured to display one or more symbols **1400** conveying information to user **600**. For example, display device **1200** may project symbols **1400** onto a symbology display area **1212** of a display component **1210** (e.g., a “see-through combiner” or a visor) which are then reflected towards user **600**. At the same time, display device **1200** may allow user **600** to see through display device **1200** so that the one or more symbols **1400** are superimposed with the pilot’s current field of view (CFOV) of the outside world. Additional or alternative display technologies may be employed including, for example, a flat substrate as a display, or a night vision goggles (NVG), while allowing the user to “see-through” the display.

[0049] The one or more symbols **1400** may be automatically and continuously displayed through placement and replacement.

[0050] To simplify the discussion that follows, the one or more symbols **1400** may hereinafter be referred to in the singular as “symbol **1400**” or the plural as “symbols **1400**”, depending on the context.

[0051] Since display device **1200** is a see-through device, different positions on the display surface can represent different angles. Milliradians (mRAD) may for example be used as angular measurement units to indicate different positions on display device **1200**.

[0052] An orientation of symbol **1400** relative to the display device coordinate system $\mathbf{D_{xyz}}$ (and therefore relative to display device **1200** or the orientation of the user’s head) is herein exemplarily expressed by a symbol coordinate system $\mathbf{S_{x\text{-}roll,y\text{-}pitch,z\text{-}yaw}}$ or $\mathbf{S_{xyz}}$ that is spatially fixed with symbol **1400** to be displayed by display device **1200**.

[0053] Optionally, symbol coordinate system $\mathbf{S_{xyz}}$ can define three symbol principal axes of rotations that are orthogonal to each other.

[0054] Optionally, origin **O** of $\mathbf{S_{xyz}}$ can be outside symbology display area **1212**.

[0055] Aspects of embodiments are directed to the display of symbols **1400** relative to the user’s or HMD wearer’s **600** total field of view (TFOV). As used herein, “TFOV” refers to the HMD wearer's view for a complete range of rotation and translation of the wearer's head, whereas the user's CFOV refers to what the HMD wearer or user can see at a given moment.

[0056] As already indicated herein, a pilot's ability to control a vehicle may become compromised due to sensory mismatch, which may include motion sickness and spatial disorientation such as vertigo and, therefore, adversely affect the pilot's situational awareness.

[0057] Reference is made to **FIGs. 2A** and **2B**, which schematically shows a scenario that may cause sensory mismatch. Normally, the orientation of a non-conformal symbols **1420**, herein exemplified as "IAS" (indicated airspeed), vertical altitude and speed scales **1420A-C**, respectively, are fixed with respect to display device **1200**. Further examples of non-conformal symbols may pertain to vital signs of user **600**, outside temperature; outside humidity; outside pressure; cabin pressure; fuel reserves; battery power; engine thrust; instrument functionality; and/or G-force on an aircraft.

[0058] Display device **1200** is shown to roll through angle +**θ** relative to the vehicle's roll axis $\mathbf{V_{x\text{-}roll}}$, and non-conformal symbol **1420** rolls along with display device **1200** to the same extent, namely through angle +**θ**. The dashed lines indicate the initial position of display device **1200** and non-conformal symbol **1420** before rotation, and the continuous lines show final orientation after rotation. Accordingly, orientation of non-conformal symbol **IAS** is altered by angle +**θ** relative to $\mathbf{V_{x\text{-}roll}}$ of cockpit **510**, possibly causing sensory mismatch. Roll orientation of the pilot's head relative to cockpit **510** may change many times during a comparatively short period of time, causing orientation of non-conformal symbol **IAS** to change relative to cockpit **510** equally often. Frequent and/or extensive changes in the orientation of non-conformal symbols such as, for example, IAS **1420A**, vertical altitude scale **1420B1** and speed scale **1420B2**, respectively, relative to cockpit **510** may increase the likelihood of sensory mismatch and/or adversely affect the pilot's situational awareness. In the **FIGs. 2A** and **2B**, continuous lines of IAS **1420A**, vertical altitude scale

1420B1 and speed scale **1420B2** schematically illustrate a “current” orientation, whereas broken lines indicate a previous orientation of IAS **1420A**, vertical altitude scale **1420B1** and speed scale **1420B2** before a change of display device **1200** to the “current” orientation.

[0059] **FIGs. 3A** and **3B** schematically exemplify how the likelihood of sensory mismatch occurrences may be reduced, according to some embodiments. Merely for the sake of clarity and to simplify the discussion that follows, without be construed limiting, vertical altitude and speed scales **1420B1** and **1420B2** are not illustrated starting from **FIGs. 3A** and **3B**, and the description below may refer to non-conformal IAS and/or any other non-formal symbol using alphanumeric designation “**1420**”.

[0060] In the embodiment shown in **FIGs. 3A** and **3B**, the roll orientation $\mathbf{S_{x\text{-}roll}}$ of non-conformal symbol **IAS** is orientationally fixed with respect to the vehicle’s roll axis $\mathbf{V_{x\text{-}roll}}$. Hence, while display device **1200** rolls through angle +**θ** relative to the vehicle’s roll axis $\mathbf{V_{x\text{-}roll}}$, the orientation of non-conformal symbol **IAS** remains unchanged with respect to the vehicle’s roll axis $\mathbf{V_{x\text{-}roll}}$, thereby possibly reducing the likelihood of sensory mismatch.

[0061] Further referring to **FIG. 4**, a gaze tracking and display (GTAD) system **1000** is operable to determine an orientation and translational position of display device **1200** relative to control station (also: cockpit) **510**, first remote control station **9510** and/or second remote control station **9511**. Alphanumeric designations “**9510**” and “**9511**” concern remote control stations, which are discussed herein in more detail in conjunction with **Figs. 11**-**13**.

[0062] Based on the determined orientation and position of display device **1200** relative to cockpit **510**, GTAD system **1000** can determine the CFOV that can be seen by pilot **600** through display component **1210**.

[0063] The pilot’s CFOV of the outside world can include, for example, a view of the aircraft’s cockpit and/or a view of the exterior of the aircraft. Optionally, a current view of the aircraft’s exterior can be conveyed by displaying user **600** an image (or sequence of images) emulating a view of the exterior. Hence, in addition or as alternative of viewing the exterior of the aircraft through a window, the pilot may view an exterior of the aircraft via a stationary display device (not shown) that is positionally fixed with respect to cockpit **510** or a remote control station. Embodiments pertaining to remote controlling a vehicle from a remote control station will be outlined further below in more detail. Optionally, symbol(s) **1400** can convey to user **600** a variety of information including, for example, the aircraft's pitch, azimuth, roll, velocity relative to ground, height, and flight direction.

[0064] In an embodiment, GTAD system **1000** comprises components and/or modules which are operable to implement a gaze tracker engine **1310** and a symbology rendering engine **1320**, e.g., as outlined herein. Generally, gaze tracker engine **1310** and symbology rendering engine **1320** are operable to implement methods, processes and/or procedures relating to the display of one or more symbols **1400** to user **600**.

[0065] The term "engine" as used herein in the context of computerized functionalities may comprise one or more computer modules. Exemplarily, a module may be a self-contained hardware and/or software component that interfaces with a larger system. A module may comprise a machine or machines executable instructions. A module may be embodied by a circuit and/or a controller programmed to cause the system to implement the method, process and/or operation as disclosed herein. For example, a module may be implemented as a hardware circuit comprising, e.g., custom Very Large Scale Integrated (VLSI) circuits or gate arrays, an Application-specific integrated circuit (ASIC), off-the-shelf semiconductors such as logic chips, transistors, and/or other discrete components. A module may also be implemented in programmable hardware devices such as field programmable gate arrays, programmable array logic, programmable logic devices and/or the like.

[0066] Gaze tracker engine **1310** may be operable to determine an estimate relating to a current position and orientation of display device **1200** relative to the cockpit of aircraft **500**. Symbology rendering engine **1320** may be operable to cause display component **1210** to provide a video output of a symbol **1400** depending on the determined current position and orientation of display device **1200**. More specifically, a type and/or orientation and/or position of a display symbol **1400** displayed by display component **1210** at any given moment may depend on a current orientation and/or position of display device **1200** relative to the cockpit of aircraft **500** as determined, e.g., by gaze tracker engine **1310**.

[0067] In an embodiment, GTAD system **1000** comprises a gaze tracker subsystem **1100** that is, e.g., embedded in vehicle **500** or in a remote control station. Gaze tracker subsystem **1100** may comprise control station gaze tracking components **1120**. Control station gaze tracking components **1120** can be operatively coupled with display gaze tracking components **1220** of display device **1200** such to allow determining an estimate of a position and/or orientation of display device **1200** relative to control station **510**. Gaze tracker subsystem **1100** may be operable to determine the user's gaze based on a head pose of the user and/or based on the user's eye-gaze direction.

[0068] Various gaze tracking technologies may be implemented by control station gaze tracking components **1120** and display gaze tracking components **1220** for determining a head pose including, for example, optical, electromagnetic, inertial sensors (e.g., one or more accelerometers and/or gyroscopes), and/or sonic-based technologies. When employing for instance electromagnetic-based technologies for gaze tracking, control station gaze tracking components **1120** may for example comprise alternating electric field generators (not shown) that are operable to produce an alternating electric field in the cockpit of aircraft **500**. Display gaze tracking components **1220** may for example include conductive coils (not shown) that are comprised in display device **1200**. Such conductive coils (not shown) are configured to produce different voltages based on a current position and orientation of display device **1200** in the cockpit of aircraft **500**. Based on the produced voltage, gaze tracker engine **1310** can determine an estimate of the position and orientation of display device **1200** relative to the cockpit of aircraft **500**, and symbology rendering engine **1320** may cause display component **1210** to provide a video output of a symbol **1400** according to the determined instant current position and orientation estimate.

[0069] In some embodiments, various technologies may be employed by gaze tracker subsystem **1100** for determining the user's eye-gaze direction or point of gaze **Px** including, for example, camera-based and/or reflection-based eye-movement tracking. Devices and/or systems (not shown) employed for tracking the user's eye-gaze direction may be head- and/or vehicle-mounted.

[0070] Clearly, same or analogous technologies may be employed for tracking gaze of a user piloting a vehicle from a remote control station.

[0071] It is noted that a position of symbology display area **1212 (FIG. 2A)** changes according to a change in position of the head of pilot **600**. Moreover, a point of intersection of (an optionally tracked) eye-gaze direction **Px** with display component **1210** may change relative to the frame that defines the boundaries of symbology display area **1212**.

[0072] Gaze tracker subsystem **1100** may comprise, in addition to control station gaze tracking components **1120**, a control station gaze tracking processor **1140**, a control station gaze tracking memory **1130**, a control station gaze tracking communication module **1150**, and a control station gaze tracking power unit **1160** for powering the various components and/or modules of control station gaze tracker subsystem **1100**.

[0073] In an embodiment, display device **1200** may comprise display gaze tracking components **1220**, display memory **1230**, display processor **1240**, display communication module **1250**, and display device power unit **1260** for powering the various components of display device **1200**. As for example schematically illustrated in **FIGs. 1A**, **1B** and **FIG. 4**, in an operable configuration, HMD wearer **600** may be located in vehicle **500**. It should be noted that separate hardware components such as processors and/or memories may be allocated for each component and/or module in GTAD system **1000**. For instance, separate processors and memories may be allocated to implement gaze tracker engine **1310** and symbology rendering engine **1320**. However, for simplicity, the following description may herein for instance generically refer to control station gaze tracking memory **1130** and to control station gaze tracking processor **1140**, and to display memory **1230** and display processor **1240** for implementing gaze tracker engine **1310**, symbology rendering engine **1320**, and/or other functions of GTAD system **1000**, e.g., as outlined herein.

[0074] The various components and/or modules of GTAD system **1000** may communicate with each other over one or more communication buses (not shown), signal lines (not shown) and/or a network infrastructure **5000**.

[0075] In embodiments, control station gaze tracking memory **1130** and/or display memory **1230** may include one or more types of computer-readable storage media including, for example, transactional memory and/or long-term storage memory facilities and may function as file storage, document storage, program storage, and/or as a working memory. As working memory, control station gaze tracking memory **1130** and/or display memory **1230** may for example be in the form of a static random access memory (SRAM), dynamic random access memory (DRAM), read-only memory (ROM), cache and/or flash memory and include, for instance, temporally-based and/or non-temporally based instructions. As long-term memory, control station gaze tracking memory **1130** and/or display memory **1230** may for example include a volatile or non-volatile computer storage medium, a hard disk drive, a solid state drive, a magnetic storage medium, a flash memory and/or other storage facility. A hardware memory facility may for example store a fixed information set (e.g., software code) including, but not limited to, a file, program, application, source code, object code, data, and/or the like.

[0076] The term “processor”, as used herein, may encompass a controller. A processor such as, for example, control station gaze tracking processor **1140** and/or display processor **1240** may be implemented by various types of processor devices and/or processor architectures including, for example, embedded processors, communication processors, graphics processing unit (GPU)-accelerated computing, soft-core processors and/or general purpose processors.

[0077] Control station gaze tracking communication module **1150** and/or display communication module **1250** may, for example, include I/O device drivers (not shown) and network interface drivers (not shown) for enabling the transmission and/or reception of data over network infrastructure **5000**, e.g., from gaze tracker subsystem **1100** to display device **1200** and vice versa. With respect to in-aircraft communication, network infrastructure **5000** may, for example, operate on and/or implement various avionics Local Area Network (LAN) communication standards including, for example, Aeronautical Radio INC. (ARINC) 429, ARINC 629, MUX Bus 1553, Controller Area Network (CAN) BUS, and/or Avionics Full-Duplex Switched Ethernet (AFDX).

[0078] Subsystem power unit **1160** and display device power unit **1260** may comprise an internal power supply. Optionally, display device power unit **1260** may comprise an interface for allowing connection to an external power supply (e.g., from aircraft **500**).

[0079] Gaze tracker engine **1310** and/or symbology rendering engine **1320** may be implemented by any suitable device, fully or partially. For example, implementations and/or processes and/or elements and/or functions of gaze tracker engine **1310** and/or symbology rendering engine **1320** may be implemented by control station gaze tracker subsystem **1100**, and/or by display device **1200**. For instance, control station gaze tracking memory **1130** and/or display memory **1230** may include instructions which, when executed e.g. by the control station gaze tracking processor **1140** and/or display processor **1240**, may cause the execution of a methods, processes and/or operations as disclosed herein. To simplify the discussion that follows, methods and processes disclosed herein may herein be discussed in conjunction with gaze tracker engine **1310** and/or symbology rendering engine **1320**. One or more hardware, software, and/or hybrid hardware/software modules may realize gaze tracker engine **1310** and/or symbology rendering engine **1320**. Gaze tracker engine **1310** and/or symbology rendering engine **1320** may operatively interface with vehicle instruments and process data relating to the vehicle instruments for generating the corresponding symbology to be displayed by display device

1200. In some embodiments, at least some or all symbology may be generated external to display device **1200**. For the symbology that is generated external to display device **1200**, communication between symbology rendering engine **1320** and display device **1200** may be mainly video.

[0080] In an embodiment, GTAD system **1000** is operable to allow selectively (also: controllably) spatially fixing the orientation of at least one symbol rotation axis (**S**$\boldsymbol{\alpha}$) of symbol coordinate system $\mathbf{S}_{xyz}$ with a principal axis descriptive of an orientation of vehicle **500**. For example, $\mathbf{S}_{\alpha}$ may be the symbol rotation axis $\mathbf{S}_{x\text{-}roll}$, which may be orientationally fixed with at least one principal axis (e.g., $\mathbf{V}_{x\text{-}roll}$) of the vehicle coordinate system $\mathbf{V}_{xyz}$.

[0081] In an embodiment, at least one further principal symbol axis ($\mathbf{S}_{\beta}$) is correspondingly selectively spatially fixable either to at least one other principal axis of vehicle **500** or of the display device coordinate system $\mathbf{D}_{xyz}$

[0082] In an embodiment, the orientational fixation of symbol rotation axes $\mathbf{S}_{\alpha}$ and $\mathbf{S}_{\beta}$ may be predetermined in GTAD system **1000** and/or occur "on-the-fly", e.g., during the piloting of aircraft **500**.

[0083] Optionally, a symbol may be descriptive of, or represent, a vehicle state vector. Such symbol may herein be referred to as "vehicle state vector symbol". Generally, a vehicle state vector symbol represents a state of the vehicle at a particular time instance. A vehicle state vector symbol can for example represent values of aircraft flight parameters such as the aircraft's flight path vector (FPV); and/or engine thrust direction and/or magnitude. Optionally, a translational position of a vehicle state vector symbol may be adjusted in accordance with the values pertaining to the vehicle state vector. To simplify the discussion that follows, without be construed limiting, embodiments and examples pertaining to a vehicle state vector may be outlined with respect to an aircraft's FPV.

[0084] In some embodiments, a translational position of a symbol **1400** (e.g., translational position of non-conformal symbol **1420**) may be adjusted (e.g., translationally fixed) in accordance with a position of vehicle state vector on display device **1200**.

Optionally, the symbol's rotational orientation may not be adjusted in accordance in accordance with the position of the vehicle state vector (e.g., the FPV).

[0085] In an embodiment, the translational adjustment of symbol **1400**, which can represent a vehicle state vector, may be predetermined in GTAD system **1000** and/or occur "on-the-fly", e.g., during the piloting of aircraft **500**. Optionally, GTAD system **1000** may be operable to adjust the translational position of a vehicle state vector symbol in accordance with a change of translational position of display device **1200** in vehicle **500** and/or in accordance with a change in a parameter value described by the vehicle state vector.

[0086] Various scenarios will be exemplified and listed below in more detail.

[0087] Further reference is now made to **FIG. 5A**, which schematically illustrates a pilot's CFOV. Symbology display area **1212** shown in **FIG. 5A** exemplarily delineates the imaginary boundaries of a region in which computer-rendered symbols **1400** can be displayed to pilot **600** by display component **1210**. It is noted that symbology display area **1212** may encompass only a part or the entire area of display component **1210**.

[0088] Further referring to **FIG. 5B**, symbols **1400** may be classified to belong to one of the following categories: conformal symbols **1410**, non-conformal symbols **1420**, or partially conformal symbols **1430**.

[0089] A symbol is considered to be "conformal" if the information that it conveys preserves a scale and/or orientation with respect to World Coordinate System **Wxyz**. Non-limiting examples of conformal symbols **1410** can include a display of an artificial or synthetic horizon **1410A**, flight path vector (FPV) **1410B**, symbol descriptive of an acquired target; symbol pointing on an incoming missing and/or the like.

[0090] and/or the like. Correspondingly, a symbol can be considered to be "non-conformal" if the information that it conveys does not or only partially preserves a scale and/or orientation with respect to **Wxyz**. Non-limiting examples of non-conformal symbols **1420** can include a display of the aircraft's fuel level and/or status, cockpit pressure, indicated air speed (IAS), and/or any other type of information describable by a scalar; ordinal; categorical; and/or interval parameter.

[0091] Additional reference is made to **FIGs. 5C** and **5D** to elaborate on the differences between conformal and partial-conformal display of symbols.

[0092] **FIG. 5C** schematically exemplifies a scenario in which azimuth bar **1430** is displayed in a conformal manner in a virtual HUD (VHUD) region **5100FL** whose boundary is schematically delineated by broken lines and herein exemplified as matching the area of a front left (**FL**) window of control station **510**. The azimuth angle is measured in a straight virtual surface which is “tangential” to the earth’s surface, optionally with the north pole as Zero azimuth, increasing clockwise relative thereto.

[0093] In the scenario exemplified in **FIG. 5C**, azimuth bar **1430** comprises ticks or markers **1431**, and a pointer **1432**. Markers **1431** indicate the azimuth angle, and pointer **1432** is fixed to the aircraft’s nose, so that azimuth bar **1430** virtually "slides" relative to pointer **1432** responsive to a change in the vehicle’s azimuth angle. The distance between each two neighboring markers **1431** may indicate a change in predetermined azimuth angle (e.g., 5 degrees). Azimuth bar **1430** is schematically illustrated in **FIG. 5C** as being displayed in a conformal manner such that angular displacement is identical to displacement of the external visual scene.

[0094] **FIG. 5D** schematically shows a scenario in which symbology display area **1212** is displaced (e.g., turned to the left), compared to the situation shown in **FIG. 5C**. To convey the same amount of information in less space, the distance between markers **1431** is condensed. Accordingly, in **FIG. 5D**, azimuth markers **1431** and pointer **1432** are shown in partial conformity with respect to the external visual scene. In some embodiments, the distance between markers may be condensed to convey more information in the same amount of space (not shown). In either case, change in azimuth angle is reduced or scaled down compared to displacements of the external visual scene. While partial conformity is herein only exemplified with respect to azimuth angle, this should by no means be construed in a limiting manner. Accordingly, additional or alternative attitude symbology may be displayed to the user in a partially conformal manner including, for example, the vehicle's pitch ladder. Additional examples of partially conformal symbols **1430** can include roll (also: bank) indication.

[0095] In some embodiments, as will be outlined further below, a FPV may also be categorized as a partially conformal symbol.

[0096] Further reference is made to **FIGs. 6A** and **6B**, schematically showing a scenario in which, initially, the orientation of both display device rotation axes $\mathbf{D_{xyz}}$ and Symbol rotation axes $\mathbf{S_{xyz}}$ are aligned with the vehicle principal axes $\mathbf{V_{xyz}}$ for all rotation axes **x-roll, y-pitch** and **z-yaw**. It is noted that display device rotation axes $\mathbf{D_{xyz}}$ may in some embodiments be considered to be principal axes of display device **1200**. Analogously, symbol rotation axes $\mathbf{S_{xyz}}$ may in some embodiments be considered to be principal axes of symbol **1400**, as if symbol **1400** was a rigid body.

[0097] To simplify the discussion that follows, the conformal symbol for FPV **1410B** has been removed so that only artificial horizon **1410A** is shown alongside non-conformal symbol **1420**, which is exemplified herein to show "IAS". The rectangle of non-conformal symbol **1420** may be a real or imaginary rectangle and is shown in **FIG. 6A** to facilitate illustrating a roll angle or orientation of non-conformal symbol **1420** relative to vehicle CS **Vxyz**. Exemplarily, the rectangular's long edge of IAS **1420**, which in the current orientation shown in **FIG. 6A** is illustrated to be parallel to principal axis with $\mathbf{V_{y\text{-}pitch}}$, is considered to coincide with the principal axis $\mathbf{S_{y\text{-}pitch}}$. The rectangle's short edge of non-conformal symbol **1420** is considered to coincide with the principal axis $\mathbf{S_{z\text{-}yaw}}$; and a direction which is normal to the rectangle and pointing in distal direction away from user **600** wearing display device**1200** and, hence, pointing in direction of the user's CFOV, is considered to coincide with $\mathbf{S_{x\text{-}roll}}$.

[0098] It is noted that for the sake of clarity and to simplify illustrations, any change in pitch and yaw orientation of display device **1200** relative to **Vxyz** is shown in the accompanying figures as a change in the display's translational position, without showing changes in a perspective view of symbology display area **1212**. Additional reference is made to **FIGs. 7A** and **7B**. In an embodiment, GTAD system **1000** may be configured so that a change in azimuth angle of display device **1200** relative to **Vxyz** does not cause a change in the display of yaw orientation of non-conformal symbol **1420. FIGs. 7A** and **7B** exemplify a scenario in which at least $S_{z\text{-yaw}}$ ($S\alpha$) is spatially fixed with respect to $V_{z\text{-yaw}}$. At least one further symbol rotation axis (S_β) (e.g., $S_{x\text{-roll}}$) may be spatially fixed to either $D_{x\text{-roll}}$ or $V_{x\text{-roll}}$, and principal axis $S_{y\text{-pitch}}$ may be spatially fixed to either $D_{y\text{-pitch}}$ or $V_{y\text{-pitch}}$. A relative displacement of non-conformal symbol **1420** with respect to symbology display area **1212** due to the spatial fixing of $S_{z\text{-yaw}}$ ($S\alpha$) with respect to $V_{z\text{-yaw}}$ is schematically illustrated by arrow **R1**. A position in which non-conformal symbol **1420** would be if $S_{z\text{-yaw}}$ ($S\alpha$) was not fixed with respect to $V_{z\text{-yaw}}$ is schematically illustrated in **FIG. 5A** by the broken lines of rectangle **1420**. A positive yaw rotation is herein expressed by angle $+\psi$. Optionally, principal axis $S_{x\text{-roll}}$, may be spatially fixed to either $D_{x\text{-roll}}$ or $V_{x\text{-roll}}$, and principal axis $S_{y\text{-pitch}}$ may be spatially fixed to either $D_{y\text{-pitch}}$ or $V_{y\text{-pitch}}$.

[0099] Further reference is made to **FIGs. 8A** and **8B**. In some embodiments, GTAD system **1000** may be configured so that at least a change in pitch orientation of display device **1200** does not cause a change in the display of pitch orientation of non-conformal symbol **1420. FIGs. 8A** and **8B** exemplify such scenario in which at least $S_{y\text{-pitch}}$ ($S\alpha$) is spatially fixed with respect to $V_{y\text{-pitch}}$. Optionally, at least one further symbol rotation axis (S_β) (e.g., symbol rotation axis $S_{x\text{-roll}}$) may be spatially fixed either with $D_{x\text{-roll}}$ or with $V_{x\text{-roll}}$, and principal axis $S_{z\text{-yaw}}$ may be spatially fixed either with $D_{z\text{-yaw}}$ or with $V_{z\text{-yaw}}$. A relative displacement of non-conformal symbol **1420** with respect to symbology display area **1212** due to the spatial fixing of $S_{y\text{-pitch}}$ ($S\alpha$) with respect to $V_{y\text{-pitch}}$ is schematically illustrated by arrow **R2**. A position in which non-conformal symbol **1420** would be if $S_{y\text{-pitch}}$ ($S\alpha$) was not fixed with respect to $V_{y\text{-pitch}}$ is schematically illustrated in **FIG. 8A** by the broken lines of rectangle **1420**. A negative pitch rotation is herein expressed by angle $-\phi$. Optionally, principal axis $\mathbf{S_{x\text{-}roll}}$, may be spatially fixed to either $\mathbf{D_{x\text{-}roll}}$ or $\mathbf{V_{x\text{-}roll}}$, and principal axis $\mathbf{S_{z\text{-}yaw}}$ may be spatially fixed to either $\mathbf{D_{z\text{-}yaw}}$ or $\mathbf{V_{z\text{-}yaw}}$.

[0100] Further referring to **FIGs**. **9A** and **9B**, GTAD system may be configured so that at least roll orientation $\mathbf{S_{x\text{-}roll}}$ ($\mathbf{S\alpha}$) of symbol coordinate system $\mathbf{S_{xyz}}$ is spatially fixed with the principal x-roll axis **Vx** of vehicle **500**. As a result, at least the roll orientation of symbol **1400** may remain fixed with respect to $\mathbf{V_{xyz}}$, despite a change in a roll angle of display device **1200** relative to vehicle coordinate system $\mathbf{V_{xyz}}$ by $\boldsymbol{\theta}$. A relative displacement of non-conformal symbol **1420** with respect to symbology display area **1212** due to the spatial fixing of $\mathbf{S_{x\text{-}roll}}$ ($\mathbf{S\alpha}$) with respect to $\mathbf{V_{x\text{-}roll}}$ is schematically illustrated by broken rotation arrow **M1**.

[0101] Optionally, the principal pitch axis (also: $\mathbf{S_{y\text{-}pitch}}$) of non-conformal symbol **1420** can be orientationally fixed either with the $\mathbf{V_{y\text{-}pitch}}$ axis of vehicle principal axes $\mathbf{V_{xyz}}$ or with $\mathbf{D_{y\text{-}pitch}}$ axis of $\mathbf{D_{xyz}}$, and the principal yaw axis (also: $\mathbf{S_{z\text{-}yaw}}$) of non-conformal symbol **1420** can be orientationally fixed either with the $\mathbf{V_{z\text{-}yaw}}$ axis of vehicle principal axes $\mathbf{V_{xyz}}$ or with $\mathbf{D_{z\text{-}yaw}}$ axis of $\mathbf{D_{xyz}}$.

[0102] Further reference is made to **FIGs. 10A** and **10B**, which schematically exemplify a tilted orientation for display device **1200** for a scenario in which principal axis $\mathbf{S_{x\text{-}roll}}$ is spatially fixed relative to $\mathbf{V_{x\text{-}roll}}$, while both $\mathbf{S_{y\text{-}pitch}}$ and $\mathbf{S_{z\text{-}yaw}}$ are spatially fixed to $\mathbf{D_{y\text{-}pitch}}$ and $\mathbf{D_{z\text{-}yaw}}$, respectively.

[0103] Referring to **Table 1**, the first row lists the vehicle's principal axes $\mathbf{V_{x\text{-}roll}}$, $\mathbf{V_{y\text{-}pitch}}$ and $\mathbf{V_{z\text{-}yaw}}$, and rows 1 to 14 list various options for orientationally fixing principal axes of rotation $\mathbf{S_{xyz}}$ of non-conformal symbol **1420** to axes $\mathbf{V_{x\text{-}roll}}$, $\mathbf{V_{y\text{-}pitch}}$ and $\mathbf{V_{z\text{-}yaw}}$. In addition, the options for translationally fixing of non-conformal symbol **1420** with respect to FPV are listed as well. It is noted that only pitch and yaw of non-conformal symbol **1420** may be translationally fixed with the FPV, but not the symbol's rotational orientation. A change in pitch of non-conformal symbol **1420** can be considered to be equivalent up/down movement, and a change in yaw of non-conformal symbol **1420** can be considered to be equivalent to a left/right movement on display device **1200**.

TABLE 1:

	$V_{x\text{-roll}}$	$V_{y\text{-pitch}}$	$V_{z\text{-yaw}}$	FPV	Exemplified in Figures:
1.	$S_{x\text{-roll}}$	N/A	N/A	N/A	**FIGs. 9A - 9B,** and **FIGs. 10A-10B**
2.	$S_{x\text{-roll}}$	$S_{y\text{-pitch}}$	N/A	N/A	Not shown
3.	$S_{x\text{-roll}}$	$S_{y\text{-pitch}}$	$S_{z\text{-yaw}}$	N/A	Not shown
4.	N/A	N/A	$S_{z\text{-yaw}}$	N/A	**FIGs. 7A-7B**
5.	N/A	$S_{y\text{-pitch}}$	$S_{z\text{-yaw}}$	N/A	Not shown
6.	$S_{x\text{-roll}}$	N/A	$S_{z\text{-yaw}}$	N/A	Not shown
6.	N/A	$S_{y\text{-pitch}}$	N/A	N/A	**FIGs. 8A-8B**
7.	$S_{x\text{-roll}}$	N/A	N/A	$S_{y\text{-pitch}}$ | up/down	Not shown
8.	$S_{x\text{-roll}}$	N/A	$S_{z\text{-yaw}}$	$S_{y\text{-pitch}}$ | up/down	Not shown
9.	N/A	N/A	$S_{z\text{-yaw}}$	$S_{y\text{-pitch}}$ | up/down	Not shown
10.	$S_{x\text{-roll}}$	N/A	N/A	$S_{z\text{-yaw}}$ | left/right	Not shown
11.	$S_{x\text{-roll}}$	$S_{y\text{-pitch}}$	N/A	$S_{z\text{-yaw}}$ | left/right	Not shown
12.	N/A	$S_{y\text{-pitch}}$	N/A	$S_{z\text{-yaw}}$ | left/right	Not shown
13.	N/A	N/A	N/A	$S_{y\text{-pitch}}$ & $S_{z\text{-yaw}}$	Not shown

14.	$S_{x\text{-roll}}$	N/A	N/A	$S_{y\text{-pitch}}$ & $S_{z\text{-yaw}}$	Not shown

[0104] Additional reference is made to **FIGs. 11** and **12**. Corresponding features are generally indicated by reference numerals with the digit "**9**". Aspects of embodiments concern also systems and methods which are employable for the remote controlling or piloting of remote controllable vehicles **9500**. In an embodiment, a remote control GTAD system **9000** may comprise one or more display devices which are located remotely from remote controllably vehicle **9500** in a location **9510**. In the discussion that follows, location **9510** may also be referred to as "remote control station **9510**".

[0105] Remote control GTAD system **9000** is operable to convey to a user **9600** located at remote control station **9510**, via the one or more display devices, a digital image of an emulated view of the exterior of remote controllable vehicle **9500** from a perspective of remote controllable vehicle **9500**.

[0106] Coordinate system $\mathbf{RC_{xyz}}$ is a Cartesian representation of the principal axes of remote control station **9510**. Coordinate system $\mathbf{V_{xzy}}$ defines an orientation of remote controllable vehicle **9500** with respect to World coordinate system $\mathbf{W_{xyz}}$. Coordinate system $\mathbf{D(wearable)_{xyz}}$ (also: $\mathbf{D(wr)_{xyz}}$) defines an orientation of external wearable display device **9200** (comprising a symbology display are **9212**) with respect to remote control station **9510**. Optionally, external wearable display device **9200** may move freely in remote control station **9510**. Symbol coordinate system $\mathbf{S_{xyz}}$ defines an orientation of a symbol that is displayed to user **9600**.

[0107] In the embodiment shown in **FIG. 12** schematically illustrating a remote control GTAD system **9001**, the one or more display devices may include, in addition to external wearable display device **9200**, a non-wearable, external display device **9700**. Coordinate system $\mathbf{D(ext)_{xyz}}$ defines an orientation of external wearable display device **9200** relative to a remote control station **9511**.

[0108] In an embodiment, a remote control station (e.g, first remote control station **9510** or second remote control station **9511**) is spatially fixed relative to world reference frame $\mathbf{W}_{xyz}$. In an embodiment, orientation and/or position of a remote control station can change relative to world reference frame $\mathbf{W}_{xyz}$. Optionally, a remote control station is comprised in another vehicle such as a ship, an aircraft, a truck, and/or the like. Optionally, a remote control station can be mounted on a moving platform (not shown) which may comprise mounts (not shown), and which may be operable to controllably change the position and/or orientation of the remote control station such that an orientation of the remote control station is fixed with respect to an attitude of remote controllable vehicle **9500**. More specifically, the orientation of a remote control station and remote controllable vehicle **9500** relative to world reference frame $\mathbf{W}_{xyz}$ may be synchronized with each other and (substantially) identical.

[0109] In some embodiments, external wearable display device **9200** may be spatially (e.g., orientationally) fixed with respect to the attitude of remote controllable vehicle **9500**, while remote control station **9510** is spatially (e.g., orientationally) fixed with respect to world reference frame $\mathbf{W}_{xyz}$. In some embodiments, both external wearable display device **9200** and the remote control station are either spatially (e.g., orientationally) fixed with respect to world reference frame $\mathbf{W}_{xyz}$ or to remote controllable vehicle **9500**.

[0110] Accordingly, a method for providing information to user **9600** for remote monitoring and/or remote controlling a vehicle **9500** that is located in a reference world space **10** via one or more display devices that are located remotely from the vehicle in a remote control station, may comprise providing a vehicle coordinate system ($\mathbf{V}_{xyz}$) that defines an attitude of the vehicle relative to a world coordinate system ($\mathbf{W}_{xyz}$) of the reference world space **10**; conveying by the one or more display devices a digital image of an emulated view of the exterior of the vehicle from a perspective of the vehicle. The one or more display devices may comprise, at least, a head-mounted display device that is wearable by the pilot **600**. The method may further comprise providing a symbol coordinate system (S_{xyz}) that is spatially associated with a symbol to be displayed on the head-mounted display device. The symbol coordinate system (S_{xyz}) defines three symbol rotation axes that are orthogonal to each other. The method may also comprise spatially fixing at least one of the symbol rotation axes (S_α) to a principal axis of rotation of remote controllable vehicle **9500**. Optionally, the method may include selectively spatially fixing at least one further symbol rotation axis (S_β) to one of the following: at least one other principal axis of rotation of remote controllable vehicle **9500**; and at least one principal axis of the head mounted display device coordinate system. Optionally, a translational position of symbol **1400** that is displayed on display device **1200** may be adjusted according to the vehicle state vector.

[0111] Further referring to **FIG. 13**, a method for providing information to user **600** of vehicle **500** (or remote controllable vehicle **9500**) via a display device **1200** (or wearable external display device **9200**) that is worn by user **600** may comprise, in an embodiment, providing a principal axes of rotation coordinate system (V_{XYZ}) that defines a vehicle orientation relative to a world coordinate system (W_{xyz}) of the reference world space **10** (step **13100**).

[0112] The method may in an embodiment further comprise providing at least one display device coordinate system (D_{xyz}) that defines a display device orientation relative to the vehicle coordinate system, wherein display device **1200** is operable to visually display to user **600** at least one first symbol (step **13200**).

[0113] In an embodiment, the method may comprise providing a symbol coordinate system (S_{xyz}) that is spatially associated with the at least one first symbol to be displayed on display device **1200** and that defines three symbol rotation axes that are orthogonal to each other (step **13300**).

[0114] In an embodiment, the method may comprise spatially fixing at least one of the symbol rotation axes (S_α) to one of a principal axis of rotation of V_{xyz}, (step **13400**). At least one further symbol rotation axis (S_β) may be correspondingly selectively spatially fixable to one of at least one other principal axis of rotation of $\mathbf{V_{xyz}}$; and at least one principal axis of the display device coordinate system $\mathbf{D_{xyz}}$.

[0115] It is noted that GTAD system **1000** is configured such that orientationally fixing a symbol rotation axes to either a principal rotation axes of the vehicle or a rotation axis of the display device as described herein, can be accomplished without requiring installation and/or arrangement of dedicated markers and/or sensors in the control station and/or on or in the display device in order to provide a reference.

[0116] As specified above, the pilot's view of the outside world that can be seen through display device **1200** can include, for example, a view of the aircraft's cockpit **510** and/or a view of the exterior of the aircraft **500** (cf. for instance to **FIG. 5A**). The view of the outside world may depend on the current orientation and position of display device **1200** relative to cockpit **510**.

[0117] Moreover, as already indicated herein, the TFOV refers to the view for a complete range of rotation and translation in cockpit **510** by the user's **600** head wearing display device **1200**. In an embodiment, the user's **600** TFOV may be divided (e.g., classified by a classifier) into at least two cockpit viewing regions, e.g., as disclosed herein. Additionally referring to **FIGs. 14A** and **14B**, a "region" of a TFOV may be defined in accordance with pilot's **600** gaze direction as determined by gaze tracker engine **1310** (**FIG. 4**). A control station such as cockpit may be spatially divided into various viewing regions of the pilot's TFOV.

[0118] Exemplarily, the boundaries of various cockpit viewing regions may be defined in a (e.g., registration) procedure in which gaze directions are operatively associated with symbology rendering engine **1320**, so that information conveyed via display component **1210** may depend on the cockpit viewing region the pilot **600** is gazing at. It is noted that a hysteresis interval may also be applied for determining if gaze is directed towards one or another cockpit viewing region.

[0119] It is noted that the expression “conveying information”, as well as grammatical variations thereof, may not only refer to altering a displayed symbol as a result of the pilot’s gaze direction, but also to making a computer-based decision regarding display or non-display of a symbol, e.g., as outlined herein below in more detail.

[0120] In an embodiment, a gaze direction of pilot **600** may be determined based on the orientation of display device **1200**. Additionally or alternatively, a pilot’s **600** gaze direction may be determined using an eye tracker (not shown), which may for example be comprised in display device **1200**.

[0121] As schematically illustrated in **FIGs. 14A** and **14B**, at l7east two cockpit viewing regions of a TFOV may optionally comprise one or more “VHUD regions” **5100**, one or more “outside VHUD regions” **5200**, and one or more “masked regions” **5300**. In some embodiments, VHUD region may be further subdivided into a conformal and non-conformal VHUD region (not shown). Conformal VHUD region may be defined such to allow the display of conformal, non-conformal and partially conformal symbology. In the non-conformal VHUD region, only non-conformal symbology may be displayed. Exemplarily, the non-conformal VHUD region may refer to viewing angles which cover areas of cockpit **510** which neither comprise instrumentation nor provide a view of the exterior of the vehicle. Such non-conformal VHUD region may herein exemplified by frame element **550**.

[0122] In an embodiment, GTAD system **1000** may be configured so that if gaze is directed towards VHUD region **5100**, symbols **1400** are displayed like on a “real” head-up display. Optionally, GTAD system **1000** may be configured so that if gaze is directed towards outside VHUD regions **5200**, then at least one orientation and/or translational position of symbols **1400** is spatially fixed with respect to at least one of the axes $\mathbf{D_{xyz}}$ of display component **1210**, instead of being spatially fixed with respect to the corresponding at least one of principal axes $\mathbf{V_{xyz}}$ of vehicle **500** when gazing towards VHUD region **5100**. For example, after a transition of a gaze direction from a VHUD region **5100** to an outside VHUD region **5200**, at least one further symbol rotation axis ($\mathbf{S_{\beta}}$) that was before the transition spatially fixed with one of the principal axes $\mathbf{V_{xyz}}$, may become spatially fixed with a corresponding or rotation axis of display $\mathbf{D_{xyz}}$.

[0123] In an embodiment, GTAD system **1000** may be configured so that when gaze is directed towards a masked region **5300**, comparatively fewer and/or different, or no symbols **1400** may displayed by display component **1210**. In an embodiment, such masked regions **5300** may spatially coincide with instrument panels of a control station **510** (e.g., of an aircraft's cockpit). Optionally, masked region **5300** may virtually "cover" or mask all instruments of control station **510**. Optionally, masked region **5300** may mask at least portions of a window of control station **510**.

[0124] Additional reference is made to **FIG. 15**. In the following description, the terms "right" and "left" are used to describe a position in cockpit **510** with respect to an imaginary symmetry plane **5050** that lies in the plane spanned by $\mathbf{V_{x\text{-}roll}}$ and $\mathbf{V_{x\text{-}yaw}}$, when gazing in direction of $\mathbf{V_{x\text{-}roll}}$. In the scenario exemplified by **FIG. 15** in which display device **1200** is considered to be positioned left of imaginary symmetry plane **5050** (when e.g., a pilot sitting in the left seat (not shown) of cockpit **510**), then any gaze direction of pilot **600** that may substantially coincide with a forward-left cockpit window **5100FL** may be defined, for the same display device **1200**, as VHUD region **5100FL**. Moreover, any one of pilot's **600** gaze direction that may substantially intersect either with a forward-right cockpit window **5200FR**, a right-side cockpit window **5200R**, or with a left-side cockpit window **5200L**, may correspondingly define outside VHUD regions **5200FR**, **5200R** and **5200L**, respectively. Furthermore, any gaze direction that may intersect with critical instrument panels such as, for example, upper instrument panel **5300up** and lower instrument panel **5300down** may be correspondingly define masked regions **5300up** and **5300down**.

[0125] Additional reference is now made to **FIG. 16A**. A current gaze direction is herein illustrated by vector $\mathbf{P_x}$. It is noted that gaze direction vector $\mathbf{P_x}$ does not necessarily have to be normal to the inner or outer surface of display component **1210**. The "inner" surface of display component **1210** is proximal, and the "outer" surface is distal to pilot **600** wearing display device **1200**. Optionally, gaze direction vector **P_x** may be orientationally and translationally fixed with respect to display device **1200** so that **P_x** can be considered to be spatially fixed with respect to **D_x**. Optionally, gaze direction vector **P_x** may be orientationally and translationally fixed with respect to the pilot's eye-gaze direction in which case the gaze direction vector **Px** may not be normal to the surfaces of display component **1210**.

[0126] In the example shown in **FIG. 16A**, gaze tracker engine **1310** may determine that the current gaze direction vector **P_x** is towards VHUD region **5100FL**. Symbology rendering engine **1320** may, accordingly, cause symbol **1400**, to be displayed by display component **1210**.

[0127] Referring now to **FIG. 16B**, gaze tracker engine **1310** may determine that another gaze direction vector **P_x** of pilot **600** is towards lower masked region **5300down**. Accordingly, symbology rendering engine **1320** may discontinue displaying symbol **1400** that was displayed while gazing towards VHUD region **5100FL**. Such discontinuation of symbol display is in **FIG. 16B** schematically illustrated by a transition of continuous lines to broken lines for symbol **1400**. Optionally, when gazing towards a masked region, the display of one or more symbols may be discontinued while continuing the display of one or more other symbols. For example, vertical altitude and speed scales (also: columns) **1420B1** and **1420B2** (cf. **FIG. 2A**) may still be displayed, e.g., in a roll-compensated manner which is exemplified in **FIG. 3A**) when gazing towards a masked region (e.g., masked region **5300_{down}**).

[0128] In some embodiments, the type of symbol displayed to the pilot may change from one category to another when changing gaze from a VHUD region to a masked region, and vice versa. For instance, when gazing towards a masked region, alternative symbols may be displayed instead of the discontinued symbol(s). The alternative symbols shown when gazing towards a masked region may for example provide an augmented view of the real-world control objects of the masked region (e.g., masked region **5300down**). The alternative symbols may for example complement information provided by and/or enhance visibility of the real-world control objects of a masked region. The alternative symbols may, for instance, provide the pilot with a visual feedback (e.g., a digital symbol superimposed on the real-life control object) to indicate towards which control object he is gazing at. In another example, a value that is associated with a control object may be displayed to the pilot as long as the pilot is gazing at it. For instance, a symbol descriptive of a radio volume may be displayed by display device **1200** as long as the pilot is gazing at the respective real-life volume control of the control panel.

[0129] Further reference is made to **FIG. 17A** and **17B**. After traversing gaze direction $\mathbf{P_x}$ from a VHUD region **5100** to an outside VHUD display region **5200** and as long as gaze direction vector $\mathbf{P_x}$ intersects with outside-VHUD display region **5200**, one or more orientations of $\mathbf{S_{xyz}}$ of symbol **1400** may become spatially fixed with respect to $\mathbf{D_{xyz}}$ of display component **1210** instead of being spatially fixed to a principal axis of rotation of $\mathbf{V_{xyz}}$ when the wearer is gazing towards VHUD region **5100**.

[0130] In some embodiments, the type of symbol displayed to the pilot may change from one category to another when changing gaze from a VHUD region to an outside-VHUD region, and vice versa. For example, as shown in **FIGs. 17C** and **17D**, information (e.g., aircraft pitch) that is conveyed by a conformal symbol **1410** pilot **600** when gazing towards VHUD region **5100FL** (**FIG. 17C**), may be conveyed to the pilot by a non-conformal symbol **1420** when the pilot is gazing towards outside VHUD display region **5200FR** (**FIG. 17D**). In some embodiments, when gazing towards outside VHUD region **5200FR**, an arrow **Q** may be displayed to indicate the pilot a direction towards he/she should traverse his/her gaze direction for viewing VHUD region **5100FL** again.

[0131] In an embodiment, after gaze direction vector $\mathbf{P_x}$ has traversed back from outside VHUD region **5200FR** towards VHUD region **5100FR**, then at least one orientation may again become spatially fixed with respect to a principal axis **Vxyz,** instead of being spatially fixed with respect to $\mathbf{D_{xyz}}$ when gazing towards the outside VHUD region **5200FR**.

Optionally, a translational position of symbol **1400** may again become spatially fixed with respect to the vehicle state vector instead of being spatially fixed with respect to $\mathbf{D}_{xyz}$ when gazing towards the outside VHUD region **5200FR**. Optionally, information that is conveyed to pilot **600** gazing towards an outside VHUD region **5200** (e.g., **5200FR)** in a non-conformal manner may be conveyed in a conformal manner when pilot **600** is gazing again towards VHUD region **5100**.

[0132] In an embodiment, gaze tracker engine **1310** and/or symbology rendering engine **1320** are operable to determine the position of a symbol **1400** relative to a boundary of a cockpit viewing region. Optionally, the translational position of a symbol may be altered depending on the gaze direction.

[0133] Additional reference is made to **FIGs. 18A** and **18B**. As already specified herein, symbol **1400** can represent a vehicle state vector, such as the FPV. In the discussion that follows, such symbol may referred to as “direction symbol”. A translational position of direction symbol **1400** may be adjusted in accordance change of the vehicle state vector.

[0134] As long as the symbol representing the vehicle state vector can be displayed to the pilot by display device **1200** in a directionally conformable manner within a given field of view (e.g., VHUD region **5100**), direction symbol **1400** may be displayed in a first or regular display mode. Otherwise stated, in the regular display mode, direction symbol **1400** is displayed in manner which conforms to the value of the direction parameter. However, if the symbol representing the vehicle state vector cannot be displayed (also: is not displayable) in a directionally conformable manner within the given field of view (e.g. when a direction parameter of the vehicle state vector would require display of the symbol outside the field of view of display device **1200**), then the symbol may be displayed in a ghosted display mode.

[0135] Considering for example FPV **1410B** as the vehicle state vector symbol, it may be displayed in one of a regular and ghosted mode depending on the amount or magnitude of (angular) drift of aircraft **500** (**FIG. 1A**) and the orientation of display device **1200**. The position of FPV **1410B** relative to artificial horizon **1410A** can indicate whether the aircraft is ascending or descending. Since the FPV may, in some embodiments, be displayed in one of a regular and ghosted mode, the FPV may be categorized as a partially-conformal symbol.

[0136] If FPV **1410B** is above artificial horizon **1410A**, aircraft **500** is ascending, and if below artificial horizon **1410A**, aircraft **500** is descending. The higher FPV **1410B** above artificial horizon **1410A**, the steeper the aircraft's ascent. The lower FPV **1410B** drops below artificial horizon **1410A**, the steeper the descent. **FIG. 18A** schematically illustrates FPV **1410B** a scenario in which it is displayed in the regular display mode. That is, the distance between FPV **1410B** and artificial horizon **1410A** corresponds to the rate of ascent of the aircraft.

[0137] In some scenarios, the magnitude of the aircraft's ascent or descent may exceed a certain displaying threshold such that FPV **1410B** cannot be displayed in a translationally conformal manner within the boundaries of VHUD region **5100**. In that case, FPV **1410** may be displayed in a second, "ghosted" mode, which is schematically illustrated in **FIG**. **18B** by the dashed lines of ghosted FPV **1410B'**. The ghosted display is to indicate to pilot **600** that the position of ghosted FPV **1410B'** is not where it actually should be. The position where FPV **1410B** actually should be displayed if it was translationally conformal, is shown in **FIG. 18B** to be within masked region **5300up**.

[0138] In correspondence with the aforesaid, aspects of embodiments may concern a method that comprises selectively displaying the vehicle state vector symbol relating to a directional parameter value in one of the following display modes: in a first, regular display mode, as long as the vehicle state vector symbol can be displayed to the user by the display device in a directionally conformable manner within a given field of view; and in a second, ghosted display mode, if the vehicle state vector symbol cannot be displayed by the display device in a directionally conformable manner within the given field of view.

[0139] In the ghosted display mode, the vehicle state vector is displayed differently than in the regular display mode. For example, line thickness, line style, line color and/or the like, may be different in the regular and the ghosted display mode. Without be construed limiting, the regular display mode of FPV **1410B** is represented in **FIG. 18A** by its continuous lines, and the ghosted display mode of FPV **1410B** is represented in **FIG. 18B** by its broken lines.

[0140] Additional reference is made to **FIG. 18C**. As already briefly mentioned herein above, a translational position of symbol **1400** (e.g., translational position of non-conformal symbol **1420**) as displayed by display device **1200** may be adjusted (e.g., translationally positioned on symbology display area **1212**) in accordance with a position of a vehicle state vector. In **FIG. 18C**, arrow $\mathbf{R_{symbol}}$ schematically illustrates traversing non-conformal symbol **1420** in accordance with the traversing of FPV **1410B** in direction of $\mathbf{R_{FPV}}$, which may be due to a change in one or more of the values associated with FPV **1410B** and/or a change in the position and/or orientation of symbology display area **1212**. Optionally, the origin O of symbol coordinate system **Sxyz** may be translationally fixed with respect to, e.g., the position of FPV **1410B**. In the embodiment exemplified by **FIG. 18C**, the roll orientation of non-conformal symbol **1420** may be spatially fixed with respect to the roll orientation of the vehicle.

[0141] Additional reference is made to **FIGs. 19** to **24**. Generally, the gaze direction of user **600** may be continuously tracked. While the gaze is tracked, it may be determined if a gaze-based object selection criterion is met. If the gaze-based object selection criterion is met, the user is provided with information (e.g., a feedback) indicating that the gaze-based object selection criterion is met.

[0142] It is noted that while embodiments discussed herein may relate to gaze-based object selection and gaze-based object selection criterion, this should by no means be construed as limiting.

[0143] In some embodiments, an object selection criterion defines the conditions for selecting a certain object by the pilot.

[0144] An object selection criterion may be based on input parameter values such as the the pilot's gaze, gesture, utterance, and/or based on any other suitable physical action. For example, a gesture tracking system (not shown) may track gestures (e.g., finger and/or hand gesturing by the user) and operable to recognize an object the pilot wants to select. Additionally or alternatively, object selection may be utterance-based (e.g., through a suitable voice command). An object selection criterion may pertain to a variety of different user inputs concurrently. For example, for an object to be selected, the conditions pertaining to both gaze-based and physical engagement inputs may have to be met simultaneously or according to a certain predetermined sequence.

[0145] A gaze-based object selection criterion may for example pertain to one or more thresholds of a difference value between a current gaze direction and a reference gaze direction towards the gaze-selectable object. It is noted that the term "reference direction" as used herein may refer to a single reference direction or to reference directions that are within a certain range. A gaze-based object selection criterion may for example be met if the difference value is below a threshold, and the gaze-based object selection criterion may not be met if the difference value is equal or above the threshold. In another example, the gaze-based object selection criterion may be met if the difference value is equal or below a threshold, and the gaze-based object selection criterion may not be met if the difference value is above the threshold.

In an embodiment, a "gaze-based object selection criterion" may take into account, *inter alia*, a hysteresis interval between two different thresholds, depending on the direction of change of the HMD wearer's gaze direction. The hysteresis interval may for example be defined by a selection threshold that is lower than a non-selection threshold, e.g., as outlined herein below. Analogously, a hysteresis interval may be applicable to additional or alternative object selection inputs.

[0146] In an embodiment, GTAD system **1000** may be operable to determine if the user's current gaze direction meets a gaze-based object selection criterion for allowing initiating an action associated with a gaze-selectable object. In other words, a gaze direction of an HMD's wearer may be considered to be directed at a gaze-selectable object if a "gaze-based object engagement criterion" is met. Correspondingly, if the "gaze-based object selection criterion" is not met, the gaze direction is considered as not be selectably directed at the gaze-selectable object.

[0147] GTAD system **1000** (cf. **FIG. 4**) may for example generate (e.g., graphically render) and display to pilot **600** a symbol that is operatively associated with a real-world control object (e.g., controls or control elements) of control station (e.g., cockpit) **510,** if the object selection criterion is met.

[0148] A gaze-based object selection criterion may for example be met if an imaginary gaze vector $\mathbf{P_x}$ representing the user's gaze direction intersects, e.g., for a certain dwell time, with a selectable virtual object which is operatively associated with a real world physical object. For example, a selectable virtual object may be operatively associated with a real world physical object and/or a vehicle operation function such as, for instance, an aircraft control element. It is noted that a "real world physical object" may include a hardware element and/or a graphical symbol displayed by a hardware element, e.g., in a masked region.

[0149] Optionally, a selectable virtual object may be defined as a virtual plane having boundaries and/or contours that correspond to and virtually "overlay" the gaze-selectable object. The operable association between a vehicle operation function and a virtual object may be such so that responsive to a gaze-based selection of the selectable virtual object, user **600** is provided with information relating to the vehicle operation function, e.g., as outlined herein below in more detail.

[0150] Methods, processes and/or procedures of gaze-based selection of a real-world control object and the display of a symbol or virtual object that is operatively associated with the vehicle operation function controllable by real-world control object may herein be referred as "actionably acquiring a real-world control object", as well as grammatical variations thereof. Optionally, "actionably object a control element" may first require "selection of the control element". The selection of a real-world control object may provide the pilot with an indication that, for example, the gaze direction intersects with selectable object, yet that at least one validation input has to be provided for actionable acquisition, such that the corresponding virtual object is displayed in VHUD region **5100**, or to spatially lock the virtual object with the gaze direction. Such validation input may for example comprise a physical action (e.g., push button actuation) during the dwell time of gaze direction on the selectable object, a gesture (e.g., a hand and/or finger gesture-based input), utterance of a command input, and/or the like. Validation may be confirmed by responsively providing pilot **600** with a sensory feedback (e.g., audible feedback). It is noted that the terms "virtual object", "virtual control element", "virtual control object" and "symbol" may herein be used interchangeably.

[0151] Non-limiting examples of real-world selectable objects can include a physical object outside the control station, e.g., as seen through a window and/or conveyed graphically via a display comprised in control station **510**; a graphical object (e.g., symbol) displayed to the user, e.g., via an HMD worn by the user; and/or a physical and/or real-world control object comprised in control station **510** such as a control element.

[0152] Control elements comprised in cockpit/control station **510** may be employed for controlling various systems of aircraft **500** (**FIG. 1A**) including, for example, the aircraft's engines, fuel pump system, flight control hydraulics, electrical system, oxygen system, navigation system, air-conditioning system, LAN communication system, wing heating/anti-ice controls, window heating controls, radio communication system, door controls, and/or the in-flight entertainment system. It is noted that, exemplarily, only a selection of the controls may be actionably acquirable by the pilot. Optionally, only non-critical real-life control objects may be actionably acquirable by the pilot. Non-limiting examples of non-critical real-control objects may include, for example, radio frequency knobs; volume knobs; metric selection switches; environmental conditioning controls (e.g., temperature, humidity, lighting, digital panel displays); and/or the like.

[0153] Cockpit control elements can include, for example, switches, dials, knobs, push buttons, levers, indicators, wheels and/or handles. Controls may require a multiple-step actuation sequence to prevent accidental actuation of the control. Optionally, an actionable acquisition of the selectable (real-world control) object may automatically initiate an automated action of generating a symbol which is operatively associated with the selected real-world object and/or the corresponding vehicle operation function, e.g., as outlined herein below in more detail.

[0154] It may further be determined if an actionable engagement criterion is met for actionably engaging a virtual object (also: a symbol) which may be associated with the selected object and/or displayed to the user. Optionally, the gaze-based object selection criterion and actionable engagement criterion may be identical. A virtual object or symbol may be actionably engageable by a gaze-based input and/or using gesture-based, utterance-based and/or any other suitable physical action. For example, a gesture tracking system (not shown) may track gestures (e.g., finger and/or hand gesturing by the user) and operable to recognize that a symbol is actionably engaged.

[0155] In some embodiments, the actionable acquisition of real-world control objects is herein exemplified with respect to a real-world control object herein referenced by alphanumeric designation "**1600A**".

[0156] As shown schematically in **FIG. 19**, a (real-world) control object **1600A** is exemplified as a rotary control knob which is employed for changing an operational scalar value (e.g., a radio communication frequency), which in the present state is set to "*10200*". Generally, a control such as a "rotary control knob" may be one-handed operable by the user. Optionally, a rotary control knob may be embodied by a consolidated control handle push button assembly.

[0157] Assuming that a pilot's gaze direction vector $\mathbf{P_x}$ meets the gaze-based object selection criterion for actionably acquiring real-world control knob **1600A** (e.g., the gaze direction vector $\mathbf{P_x}$ intersects with the said virtual object **1600B** for a predetermined dwell time), a symbol may be displayed indicating pilot **600** that gaze-based selection criterion is met. Optionally, the symbol may be spatially associated with the real-world control object. Optionally, the displayed symbol may represent virtual control object **1600B**. Virtual control object **1600B** may for example be mixed with or superimposed onto real-world rotary control knob **1600A** to convey to pilot **600** a combined imagery of the real-world rotary control knob **1600A** and virtual control object **1600B**. In **FIG. 20**, virtual control object **1600B** is shown as dashed lines extending along the contour edges of real-world rotary control knob **1600A**. A symbol coordinate system $\mathbf{S_{xyz}}$ is spatially associated with a virtual control object **1600B**, which may represent a virtual rotary control knob. To simplify the discussion that follows, the terms "virtual control object **1600B**" and "virtual control knob **1600B**" may herein be used interchangeably. Virtual control knob **1600B** can include the scalar display that is associated therewith.

[0158] In an embodiment, once the actionable acquisition is completed, the virtual control objects may be displayed on symbology display area **1212** (cf. for instance to **FIG. 5A**) in a spatially fixed relationship with the pilot's gaze direction (e.g., spatially fixed with the orientation and position of display device **1200** or with the pilot's eye-gaze direction). Merely for the sake of clarity, illustration of symbology display area **1212** is omitted from **FIGs. 19-22**. The spatial fixing of virtual control objects (e.g., virtual rotary control knob **1600B**) with respect to the pilot's gaze direction may in an embodiment be accomplished as schematically shown in **FIGs. 20** by a progression of broken lines representing the traversing of the virtual control objects in correspondence with gaze direction $\mathbf{P_x}$ which is tracked by GTAD system **1000**. Optionally, the pilot's gaze direction may always intersect with a geometric center of a virtual control objects such as rotary control knob **1600B**. Optionally, a virtual control object such as virtual rotary control knob **1600B** may be displayed to pilot **600** at some predetermined or dynamically adjustable position relative to the pilot's current gaze direction.

[0159] In an embodiment, an actionable acquired virtual control object that is displayed in accordance with the pilot's gaze direction vector $\mathbf{P_x}$, may be "handed over" to become, at least partially, translationally and/or orientationally fixed with respect to another reference coordinate system. For example, after completion of the object-handoff procedure (described in more detail), display of the virtual control objects may be confined within VHUD region **5100**. Optionally, a virtual control object (e.g., control object **1600B**) may become translationally fixed with a pilot-selected intersection point of the gaze direction vector $\mathbf{P_x}$ with VHUD region **5100**.

[0160] Optionally, at least one first selected symbol rotation axis ($\mathbf{S_\alpha}$) of the virtual control object may become orientationally fixed, correspondingly, to at least one principle axis of the vehicle. Optionally, at least one further symbol rotation axis ($\mathbf{S_\beta}$) may be selectively spatially fixable to one of: at least one at least one further principle axis of the vehicle; and at least one axis of the display device coordinate system. Optionally, the translational position of a symbol may be displayed in accordance with an operational state of aircraft **500**.

[0161] A procedure of handing over an actionably acquired virtual control object may be initiated responsive to receiving a suitable input at GTAD system **1000** meeting an object handoff criterion. The object handoff criterion may for example relate to the pilot's gaze direction towards VHUD region **5100FL** and/or a physical action performed by the pilot. For example, the object handoff criterion may be met if pilot **600** gazes at a certain area of VHUD region **5100FL** for a predetermined dwell time to designate the area as a "locked-in area" (not shown). Optionally, display of the virtual object may then be spatially fixed with respect to a geometric center of the locked-in area. Optionally, display of the virtual object may be spatially fixed with respect to a virtual intersection point between a current gaze direction $\mathbf{P_x}$ with VHUD region **5100FL** at the time the object handoff criterion is met. In some embodiments, the virtual intersection point may be displayed to pilot **600** in the form of a specific (e.g. pointer) symbol (not shown).

[0162] In another embodiment, once the actionable acquisition is completed, a virtual control object (e.g., virtual rotary control knob **1600B** may be displayed immediately at a predetermined position of VHUD region **5100FL**, without requiring pilot **600** to change his/her gaze direction towards VHUD region **5100FL** for spatially associating the virtual control object with VHUD region **5100FL**. For example, virtual rotary control knob **1600B** may be substantially immediately displayed in a spatially fixed manner relative to VHUD region **5100FL** after the actionable acquisition of the real-world control object is completed.

[0163] In an embodiment, after the virtual symbol is handed off (e.g., positionally confined within VHUD region **5100**), its display may change in accordance with an input provided at the real-world control object with which the virtual symbol is operatively coupled with. Hence, information conveyed by the virtual control object to user **600** is selectable based on an input provided by the user via the real-world control object. For example, as shown schematically in **FIGs. 21** and **22**, imparting a rotary motion on real-world rotary control knob **1600A** may cause GTAD system **1000** to animate a corresponding rotary motion of virtual rotary control knob **1600B**. Additionally or alternatively, the computerized display of information associated with real-world control object **1600B** may be altered in accordance with the rotary input provided at real-world control object **1600A**, e.g., by pilot **600**. For example, as shown schematically in **FIG. 21**, rotating real-world rotary control knob **1600A** in clockwise direction **T1** may cause animation of virtual rotary control knob **1600B** by GTAD system **1000** to simulate a corresponding rotary motion thereof. Further, the value associated with real-world control knob may change accordingly. A change in a displayed value responsive to imparting a clockwise rotary motion **T1** on real-world rotary control knob **1600A** is herein exemplified by a change from “10200” in **FIG. 20** to “10199” in **FIG. 21**. A change in a displayed value responsive to imparting a counterclockwise rotary motion **T2** on real-world rotary control knob **1600A** is herein exemplified by a change from "10200" in **FIG. 20** to "10201" in **FIG. 22**.

[0164] In an embodiment, a virtual symbol that is operatively associated with an actionably acquired real-world control object may be operatively selectable or engagable if, e.g., a corresponding gaze-based virtual object selection criterion is met. According to one option, responsive to actionably engaging the virtual object, a state of a vehicle operation function (e.g., radio frequency or volume level) associated with the virtual object may be changed, e.g., without requiring performing a physical action on the acquired real-world control object. For example, actionably engaging virtual object **1600B** to change, for example, display of "10200" to "10199" on VHUD region **5100FL** can cause a corresponding change in the value (also from "10200" to "10199") displaye by the real-world display associated with real-world control knob **1600A**.

[0165] In some embodiments, actionably acquirable real-world may include rotary control knobs which can change values or states (e.g., "ON"/ "OFF") irrespective of the knobs' initial orientation. In some embodiments, only rotary control knobs may be actionably acquirable by the pilot which can change values or states (e.g., "ON"/ "OFF") irrespective of the knobs' initial orientation.

[0166] According to some embodiments, the same virtual object can be selectively operatively associated with different real-world control objects. In the **FIGs. 21** and **22**, virtual rotary control knob **1600B** is exemplified as being operatively associated with real-world rotating control knob **1600A** (e.g., for selecting radio frequencies). Virtual object **1600B** may subsequently be operatively associated by the pilot with another real-world rotating knob (not shown) which may for example be employed to select the cabin's temperature. A series of suitable inputs that collectively meet a "symbol association-change criterion" may be predefined and/or provided by the pilot. Optionally, the pilot may change the operable association of a virtual object from one real-world control object to another real-world control object.

[0167] In some embodiments, where applicable, a virtual object that is operatively associated with an actionably acquired real-world control object may be selectively displayed in a conformal or a non-conformal manner.

[0168] In some embodiments, the display of a virtual object that is operatively associated with an actionably acquired real-world control object may be discontinued, e.g., responsive to receiving a corresponding input from the pilot.

[0169] Additional reference is made to **FIG. 23**. Generating and displaying to the pilot a symbol that is operatively associated with a real-world control object may involve a method that comprises determining a current gaze direction or tracking a pilot's gaze direction (step **23100**). The method may then further comprise determining if the current gaze direction meets a gaze-based object selection criterion (step **23200**) for actionably acquiring a real-world control object. The method may additionally comprise displaying, if the gaze-based object selection criterion is met, a symbol that is operatively associated with the real-world control object (step **23300**).

[0170] In one example, if HMD wearer **600** (cf. **FIG. 1B**) changes his gaze direction towards the object, a gaze-based object criterion selection may met if and as long the wearer's gaze direction intersects with a first area of a virtual selectable object, defining the selection threshold. On the other hand, the gaze-based object selection criterion stops to be met if the current gaze direction seizes to intersect with a second area of the virtual selectable object which is enlarged compared to the first area of the virtual selectable object and which defines the non-selection threshold.

[0171] In another example, if the HMD wearer (e.g., a pilot) (cf. **FIG. 1B**) changes his gaze direction towards the object, a gaze-based object selection criterion may be met if and as long as the difference value (e.g., the angle) between the current and a virtual gaze direction towards the object drops below, or becomes equal or drops below the selection threshold. On the other hand, the gaze-based object selection criterion seizes to be met if the difference value exceeds, or becomes equal to or exceeds the non-selection threshold which is higher than the selection threshold.

[0172] The term “virtual gaze direction” refers to a possible future gaze direction of pilot **600** (cf. **Fig. 1B**), as opposed to a current or actual gaze direction of pilot **600** (cf. **Fig. 1B**) at a particular time instance, as determined by GTAD system **1000**.

[0173] Optionally, the selection threshold may be set to be lower than the non-selection threshold by a magnitude of 0.05 radians or less, by 0.04 radians or less, by 0.03 radians or less, by 0.02 radians or less, or by 0.01 radians or less.

[0174] Additional reference is made to **FIGs. 24A** and **24B**. According to some embodiments, a plurality of (e.g., non-conformal) symbols **1400** may be displayed in VHUD region **5100**. At least two of the plurality of symbols **1400** may be different from one another. That is, the at least two symbols may, for example, pertain to different operating parameters of vehicle **500**, display device **1200** and/or vital signs of user **600**. Accordingly, the at least two symbols may have different functionalities and pertain, for example, to different vehicle operation functions.

[0175] Optionally, the number of non-conformal symbols **1400** to be displayed in VHUD region **5100** and their corresponding functionality may be customizable, e.g., per each user, vehicle and/or display device. Optionally, the non-conformal symbols **1400** are automatically displayed, at least once display device **1200** is worn by user **600** and operationally coupled with vehicle **500**. In other words, pilot-initiated actionable instrument acquisition as described with respect to **FIGs. 19-22** may not be required in order for the non-conformal symbols **1400** to be displayed in VHUD region **5100** in symbology display area **1212**.

[0176] Optionally, the symbols **1400** may be gaze-, gesture, utterance-based and/or otherwise selectable and/or actionably engageable by user **600**, if a selection criterion and/or actionably engagement criterion is met, respectively.

[0177] Optionally, symbols **1400** may be selectable through a physical action (e.g., gesture-based selection, gaze-based selection, utterance-based selection, push button and/or control knob actuation) by user **600**. A non-conformal symbol **1420** for instance may, for example, first preselected by scrolling sequentially from left to right (or vice versa) over non-conformal symbols **1420**, which may be stationary with respect to VHUD region **5100**. The scrolling may be accomplished in a one-handed manner by user **600** using, e.g., a rotary control knob (not shown) which moves a "selector", exemplified herein by dashed box, over the stationary non-conformal symbols **1420**. In another embodiment, the selector may be stationary with respect to VHUD region **5100**, and the symbols **1420** may be moved relative to the selector. While **FIGs. 24A** and **24B** exemplify embodiments with respect to non-conformal symbols **1420**, this should not be construed in a limiting manner.

[0178] A symbol **1400** such as a non-conformal symbol **1420** may be highlighted, colored and/or otherwise indicated as "selected". The selected non-conformal symbol **1420** may then be actionably engaged, e.g., using a push button (not shown), using gaze-based selection, gesture-based selection, and/or any other physical action. Responsive to actionable engaging a non-conformal symbol **1420** by user **600**, a corresponding command input may be provided to vehicle **500**. Moreover, the display of the symbol may change accordingly. For instance, non-conformal symbol **1420** may concern the activation ("ON") or deactivation ("OFF") of an air-conditioning (also: "A/C") system. In **FIG. 24A**, the A/C system (non-conformal symbol **1420C2**) is shown as turned to "OFF" and actionably engaged (schematically indicated by dashed box and the bold fonts), such to be turned "ON" (**FIG. 24B**). Moreover, in **FIG. 24A**, the synthetic vision system (SVS) is shown to be unselected, whereas in **FIG. 24B**, the SVS is shown as being actionably engaged, schematically illustrated by the bold fonts and the dashed box around non-conformal symbol **1420C3**. In both FIGs. **24A** and **24B**, the "12XA" symbol (non-conformal symbol **1420C1**) is shown as being unselected.

[0179] In an embodiment, the same control (not shown) can be used to actionably engage a selected non-conformal symbols **1420A-C**. For example, the same real-world control knob **1600A** schematically shown in **FIG. 22** may be used to actionably engage any one of non-conformal symbols **1420A-C** selected by pilot **600**.

[0180] In accordance with the embodiments outlined herein with respect to **FIGs. 19-24B**, display device **1200** is adapted to receive an input from user **600** for selecting and/or controlling various systems of vehicle **500**. Accordingly, display device **1200** may be modified from a device which merely conveys information to user **600**, to a device which is can receive inputs from user **600**.

[0181] Additional reference is made to **FIG. 25**. A method of controlling a vehicle operation function may include displaying, by display device **1200** worn by user **600**, a plurality of selectable non-conformal symbols which are associated with respective plurality of vehicle operation functions (step **25100**).

[0182] As indicated by step **25200**, the method of controlling a vehicle operation function may further include selecting a symbol of the plurality of symbols for allowing actionably engaging the selected symbol by user **600**. A symbol may be selected if the object selection criterion is met.

[0183] Additional examples:

[0184] Example 1 concerns a method for providing information to a user of a vehicle via a display device that is worn by the user, the method comprising: providing a vehicle coordinate system ($\mathbf{V}_{xyz}$) representing the principle axes of rotation of the vehicle for defining a vehicle orientation relative to a world coordinate system ($\mathbf{W}_{xyz}$) of a reference world space; providing at least one display device coordinate system ($\mathbf{D}_{xyz}$) that defines a display device orientation relative to the vehicle coordinate system, wherein the display device is operable to visually display to the user at least one first symbol; and providing a symbol coordinate system ($\mathbf{S}_{xyz}$) that is spatially fixed with the at least one first symbol to be displayed on the display device and that defines three symbol rotation axes that are orthogonal to each other; spatially fixing (e.g., during display of the at least one first symbol) at least one of the symbol rotation axes (**S_α**) to a vehicle principal axis of rotation descriptive of an orientation of the vehicle. Optionally, at least one further symbol rotation axis (**S_β**) is correspondingly selectively spatially fixable or fixed (e.g., during display of the at least one first symbol) to one of: at least one other principal axis of rotation of the vehicle; and at least one display rotation axis of the display device coordinate system

[0185] Example 2 includes the subject matter of example 1 and, optionally, translationally adjusting a position of the displayed at least one first symbol in accordance with a vehicle state vector.

[0186] Example 3 includes the subject matter of example 2 and, optionally, wherein the vehicle state vector pertains to one or more of the following: a flight path vector; and engine thrust direction and/or magnitude thereof.

[0187] Example 4 includes the subject matter of example 3 and, optionally, further comprises selectively displaying a symbol of the at least one first symbol that represents the vehicle state vector in one of the following display modes: in a first, regular display mode, as long as the symbol representing the vehicle state vector can be displayed to the user by the display device in a directionally conformable manner within a given field of view; and in a second, ghosted display mode, if the symbol representing the vehicle state vector cannot be displayed by the display device in a directionally conformable manner within the given field of view.

[0188] Example 5 includes the subject matter of any one of the examples 1 to 4 and, optionally, wherein providing the symbol coordinate system (**S_{xyz}**) on the display device is operable at all and any orientation of the symbol coordinate system (**S_{xyz}**) relative to vehicle coordinate system (**V_{xyz}**).

[0189] Example 6 includes the subject matter of any one of the examples 1 to 5 and, optionally, wherein the at least one of the symbol rotation axes (**S_α**) is a roll orientation that is spatially fixed, correspondingly, to the roll orientation of the vehicle coordinate system (V_{xyz}); and wherein the at least one further symbol rotation axis (S_{β}) is a pitch and/or yaw orientation of the symbol coordinate system (S_{xyz}) that is spatially fixed or fixable, correspondingly, to a pitch and/or yaw orientation of the display device coordinate system (D_{xyz}) relative to the vehicle coordinate system (V_{xyz}).

[0190] Example 7 includes the subject matter of any one of the examples 1 to 6 and, optionally, providing a pointer symbol coordinate system (P_{xyz}) that is spatially associated with a pointer symbol to be displayed on the display device and that defines at least two pointer symbol translational axes (y-z) that are orthogonal to each other.

[0191] Example 8 includes the subject matter of example 7 and, optionally, determining a first current gaze direction of the user; and displaying on the display device the pointer symbol concurrently with the at least one first symbol, wherein the pointer symbol indicates the first current gaze direction of the user.

[0192] Example 9 includes the subject matter of any one of the examples 1 to 8 and, optionally, wherein the displayed at least one first symbol comprises a user interface object that is selectively actionably engageable by the user.

[0193] Example 10 includes the subject matter of example 8 or 9 and, optionally, tracking gaze of the user; determining if a gaze-based object selection criterion is met; and if the gaze-based object selection criterion is met, providing the user with information indicating that the gaze-based object selection criterion is met.

[0194] Example 11 includes the subject matter of example 10 and, optionally, determining if an actionable engagement criterion is met for actionably engaging a virtual object that is associated with the selected user interface object.

[0195] Example 12 includes the subject matter of example 11 and, optionally, wherein the selection criterion refers to any one of the following: a dwell time of the first current gaze direction within a predetermined interval; and/or a physical action performed by the user.

[0196] Example 13 include the subject matter of example 7 and, optionally, determining a second current gaze direction of the user; determining a second difference value between the second current gaze direction and at least one virtual direction; and if the second difference value exceeds a second difference threshold, spatially fixing the at least one further symbol rotation axis (**S_β**) of the symbol coordinate system (**S_{xyz}**) to the display device coordinate system (**D_{xyz}**).

[0197] Example 14 includes the subject matter of example 13 and, optionally, spatially fixing the at least one of the symbol rotation axes (**S_α**) to the display device coordinate system (**D_{xyz}**).

[0198] Example 15 includes the subject matter of examples 13 or 14 and, optionally, displaying at least one second symbol in correspondence with and instead of the at least one first symbol.

[0199] Example 16 includes the subject matter of example 15 and, optionally, determining a third difference value between a third current gaze direction and the at least one virtual gaze direction; and if the third difference value is below a third difference threshold value: spatially fixing, at least one of the symbol rotation axes (**S_α**) to at least one of the axes of the vehicle coordinate system (**V_{xyz}**) for displaying the at least one first symbol.

[0200] Example 17 includes the subject matter of any one of the examples 1 to 16 and, optionally, wherein the at least one first symbol relates to any one of the following: a non-conformal symbol; and a conformal symbol; wherein the conformal symbol relates to any one of the following: a fully conformal symbol; and a partially conformal symbol.

[0201] Example 18 includes the subject matter of example 17 and, optionally, wherein a symbol that is displayed in a conformal manner can be adapted to be displayed in a manner to suit a non-conformal representation setting, and vice versa.

[0202] Example 19 includes the subject matter of examples 17 or 18 and, optionally, wherein the non-conformal symbol is descriptive of any one of the following: a value relating to a parameter describable by a scalar; ordinal; categorical; and/or interval parameter.

[0203] Example 20 includes the subject matter of any one of examples 17 to 19 and, optionally, wherein the non-conformal symbol comprises user-selectable values.

[0204] Example 21 concerns a method for providing a user with information about a remotely operated vehicle via one or more display devices of a remote control station which is located remotely from the remotely operated vehicle, the one or more display devices comprising a head-mounted display (HMD) device, the method comprising: providing a vehicle coordinate system ($\mathbf{V}_{xyz}$) that defines an orientation of the remotely operated vehicle relative to a world coordinate system ($\mathbf{W}_{xyz}$) of a reference world space; providing an HMD device coordinate system ($\mathbf{D}_{xyz}$) defining an orientation of the HMD device relative to the remote control station; conveying to the user, by the one or more display devices comprising the HMD device, a digital image of an emulated view of the exterior of the remotely operated vehicle from a perspective of the remotely operated vehicle; providing a symbol coordinate system ($\mathbf{S}_{xyz}$) that is spatially associated with a symbol to be displayed by the HMD device, wherein the symbol coordinate system ($\mathbf{S}_{xyz}$) defines three symbol rotation axes that are orthogonal to each other; spatially fixing at least one of the symbol rotation axes ($\mathbf{S}_{\alpha}$) to a principal axis of rotation of the remotely operated vehicle; and, during display of the symbol, selectively spatially fixing at least one further symbol rotation axis ($\mathbf{S}_{\beta}$) to one of: at least one other principal axis of rotation of the remotely operated vehicle; and at least one principal rotation axis of the HMD coordinate system ($\mathbf{D}_{xyz}$).

[0205] Example 22 includes the subject matter of example 21 and, optionally, wherein the one or more display devices further comprise a non-wearable display device which is stationary with respect to the remote control station.

[0206] Example 23 includes the subject matter of examples 21 or 22 and, optionally, wherein the remote control station is orientationally fixed to one of the following: the reference world space; the vehicle coordinate system $\mathbf{V_{xyz}}$ of the remotely operated vehicle; and a control station carrier platform which is movable relative to the reference world space and which comprises the remote control station.

[0207] Example 24 includes the subject matter of example 23 and, optionally, wherein the control station carrier platform comprises one of the following: a command and control aircraft; a naval vessel ship; and a motion platform assembly.

[0208] Example 25 concerns a method for generating and displaying by a display device that is worn by a user located in a control station, a symbol that is operatively associated with an operation function of the vehicle, the method comprising: determining a first gaze direction of the user; determining a first difference value between the first gaze direction and a first virtual gaze direction towards a real-world control object comprised in the control station and associated with a vehicle operation function; determining, while the first difference value is within a predetermined interval for a certain time period, if a gaze-based object selection criterion is met; and displaying by the display device a symbol that is operatively associated with the vehicle operation function relating to the real-world control object, if the gaze-based object selection criterion is met.

[0209] Example 26 includes the subject matter of example 25 and, optionally, determining a second difference value between a second gaze direction and a second virtual gaze direction towards a field-of-view (FOV) region of another real-world control object of the vehicle; and spatially fixing at least one of the symbol rotation axes ($\mathbf{S_{\alpha}}$) of the symbol, correspondingly, to at least one of the axes of the vehicle coordinate system ($\mathbf{V_{xyz}}$) defining an orientation of the vehicle relative to a reference world space, if the second difference value meets an object handoff criterion.

[0210] Example 27 includes the subject matter of example 26 and, optionally, spatially fixing at least one further symbol rotation axis ($\mathbf{S_{\beta}}$) to one of: at least one other principal axis of rotation of the vehicle; and at least one display rotation axis of a display device coordinate system (**D_{xyz}**) defining an orientation of the display device relative to the vehicle.

[0211] Example 28 includes the subject matter of examples 26 or 27 and, optionally, wherein the object-handoff criterion refers to any one of the following: a dwell time during which the second difference value is within a predetermined interval; and/or a physical action performed by the user.

[0212] Example 29 includes the subject matter of any one of the examples 26 to 28 and, optionally, determining a third difference value between a third gaze direction and a third virtual gaze direction towards the displayed symbol; and providing the user with information indicative of a difference between the third gaze direction and the third virtual gaze direction towards the displayed symbol, if a third level difference value is within a predetermined interval for at least a certain time period.

[0213] Example 30 includes the subject matter of example 29 and, optionally, determining if an object selection criterion is met for selecting the displayed symbol.

[0214] Example 31 includes the subject matter of example 30 and, optionally, wherein the object selection criterion refers to any one of the following: a dwell time of the third gaze direction within the predetermined interval; and/or a physical action performed by the user.

[0215] Example 32 includes the subject matter of example 30 or 31 and, optionally, wherein, if the selection criterion is met, an operational state of the vehicle can be altered responsive to actionably engaging the symbol.

[0216] Example 33 includes the subjecdt matter of example 32 and, optionally, wherein actionably engaging the symbol comprises engaging another control that is operatively associated with the displayed symbol for controlling a corresponding vehicle operation function.

[0217] Example 34 includes the subject matter of example 33 and, optionally, wherein the other control comprises a rotary control knob requiring a multiple-step actuation sequence to prevent accidentally actionably engaging the displayed symbol.

[0218] Example 35 includes the subject matter of example 34 and, optionally, wherein the rotary control knob comprises a push button rotary knob.

[0219] Example 36 includes the subject matter of any one of the examples 25 to 35 and, optionally, wherein the vehicle operation function pertains to displaying information about an operational state of the vehicle and/or vital signs of the user.

[0220] Example 37 includes the subject matter of any one of the examples 25 to 36 and, optionally, wherein the displayed symbol can be selectively operatively associated with different operating functions of the vehicle.

[0221] Example 38 concerns a method for controlling a vehicle by a user, the method comprising: displaying, by a display device worn by the user, a plurality of selectable non-conformal symbols which are associated with a respective plurality of vehicle operation functions; and if a selection criterion is met, selecting a symbol of a plurality of symbols for allowing actionably engaging the selected symbol by the user.

[0222] Example 39 includes the subject matter of example 38 and, optionally, further comprises actionably engaging the symbol if an actionable engagement criterion is met.

[0223] Example 40 includes the subject matter of example 38 or 39 and, optionally, wherein selecting and/or actionably engaging the symbol comprises physically engaging a control.

[0224] Example 41 includes the subject matter of example 41 and, optionally, wherein the control is one-handed operable by the user.

[0225] Example 42 includes the subject matter of examples 40 or 41 and, optionally, wherein the control comprises a push button rotary control knob assembly that is consolidated in a single control knob.

[0226] Example 43 concerns a gaze tracking and display (GTAD) system operable to provide information to a user of a vehicle via a display device that is worn by the user, the system comprising: one or more processors; and one or more memories storing software code portions executable by the one or more processors to cause the GTAD system to perform the following steps: providing a vehicle coordinate system ($\mathbf{V}_{xyz}$) that defines a vehicle orientation relative to a world coordinate system ($\mathbf{W}_{xyz}$) of a reference world space; providing at least one display device coordinate system ($\mathbf{D}_{xyz}$) that defines a display device orientation relative to the vehicle coordinate system, wherein the display device is operable to visually display to the user at least one first symbol; and providing a symbol coordinate system ($\mathbf{S}_{xyz}$) that is spatially fixed with the at least one first symbol to be displayed on the display device and that defines three symbol rotation axes that are orthogonal to each other; spatially fixing (e.g., at least during the display of the at least one first symbol), at least one of the symbol rotation axes ($\mathbf{S}_{\alpha}$) to a vehicle principal axis of rotation descriptive of an orientation of the vehicle.

[0227] Example 44 includes the subject matter of example 43 and, optionally, wherein (e.g., during the display of the at least one first symbol), at least one further symbol rotation axis ($\mathbf{S}_{\beta}$) is correspondingly selectively spatially fixable or fixed to one of: at least one other principal axis of rotation of the vehicle; and at least one display rotation axis of the display device coordinate system.

[0228] Example 45 concerns a computer program product operable to provide information to a user of a vehicle via a display device that is worn by the user, the computer program product comprising a non-transitory tangible storage medium and/or a transitory storage medium readable by one or more processing circuits and storing instructions for execution by the one or more processing circuit for performing a method comprising: providing a vehicle coordinate system ($\mathbf{V}_{xyz}$) that defines a vehicle orientation relative to a world coordinate system ($\mathbf{W}_{xyz}$) of a reference world space; providing at least one display device coordinate system ($\mathbf{D}_{xyz}$) that defines a display device orientation relative to the vehicle coordinate system, wherein the display device is operable to visually display to the user at least one first symbol; and providing a symbol coordinate system (**S_{xyz}**) that is spatially fixed with the at least one first symbol to be displayed on the display device and that defines three symbol rotation axes that are orthogonal to each other; spatially fixing at least one of the symbol rotation axes (**S_α**) to a vehicle principal axis of rotation descriptive of an orientation of the vehicle; and wherein at least one further symbol rotation axis (**S_β**) is correspondingly selectively spatially fixable or fixed to one of: at least one other principal axis of rotation of the vehicle; and at least one display rotation axis of a display device coordinate system (**Dxyz**).

[0229] Example 46 concerns a gaze tracking and display (GTAD) system operable to provide information to a user of a vehicle via a display device that is worn by the user, the GTAD system comprising: a gaze tracker subsystem of a control station for controlling a vehicle, the gaze tracker subsystem comprising station gaze tracker components; a wearable display device comprising display gaze tracking components; a gaze tracker engine for tracking gaze of the user wearing the wearable display device, wherein the gaze of the user is tracked based on information provided by the gaze tracker subsystem and the wearable display device; and a symbology rendering engine for causing display of at least one first symbol to the user via the wearable display device; wherein, a symbol coordinate system (**S_{xyz}**) is spatially fixed with the at least one first symbol and defines three symbol rotation axes that are orthogonal to each other; wherein (e.g., at least during the display of the at least one first symbol and the tracking of the user's gaze), at least one of the symbol rotation axes (**S_α**) is spatially fixed by the symbology rendering engine to a vehicle principal axis of rotation descriptive of an orientation of the vehicle.

[0230] Example 47 includes the subject matter of example 46 and, optioally, wherein at least one further symbol rotation axis (**S_β**) is correspondingly selectively spatially fixed or fixable by the symbology rendering engine to one of: at least one other principal axis of rotation of the vehicle; and at least one display rotation axis of a display device coordinate system (**Dxyz**).

[0231] Example 48 concerns a computer program product directly loadable into an internal memory of a digital computer, the computer program product comprising software code portions for performing the steps of any one of the claims 1 to 42 when the computer program product is run on a computer.

[0232] It is noted that, where applicable, embodiments exemplified herein are analogously employable in remote control applications.

[0233] It is noted that the expressions “concurrently”, “simultaneously”, “in real-time”, “constant” as used herein may also encompass, respectively, the meaning of the expression “substantially concurrently”, “substantially simultaneously”, “substantially in real-time” and “substantially constant”.

[0234] Any digital computer system, module and/or engine exemplified herein can be configured or otherwise programmed to implement a method disclosed herein, and to the extent that the system, module and/or engine is configured to implement such a method, it is within the scope and spirit of the disclosure. Once the system, module and/or engine are programmed to perform particular functions pursuant to computer readable and executable instructions from program software that implements a method disclosed herein, it in effect becomes a special purpose computer particular to embodiments of the method disclosed herein. The methods and/or processes disclosed herein may be implemented as a computer program product that may be tangibly embodied in an information carrier including, for example, in a non-transitory tangible computer-readable and/or non-transitory tangible machine-readable storage device. The computer program product may directly loadable into an internal memory of a digital computer, comprising software code portions for performing the methods and/or processes as disclosed herein.

[0235] Additionally or alternatively, the methods and/or processes disclosed herein may be implemented as a computer program that may be intangibly embodied by a computer readable signal medium. A computer readable signal medium may include a propagated data signal with computer readable program code embodied therein, for example, in baseband or as part of a carrier wave. Such a propagated signal may take any of a variety of forms, including, but not limited to, electro-magnetic, optical, or any suitable combination thereof. A computer readable signal medium may be any computer readable medium that is not a non-transitory computer or machine-readable storage device and that can communicate, propagate, or transport a program for use by or in connection with apparatuses, systems, platforms, methods, operations and/or processes discussed herein.

[0236] The terms “non-transitory computer-readable storage device” and “non-transitory machine-readable storage device” encompasses distribution media, intermediate storage media, execution memory of a computer, and any other medium or device capable of storing for later reading by a computer program implementing embodiments of a method disclosed herein. A computer program product can be deployed to be executed on one computer or on multiple computers at one site or distributed across multiple sites and interconnected by one or more communication networks.

[0237] These computer readable and executable instructions may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks. These computer readable and executable program instructions may also be stored in a computer readable storage medium that can direct a computer, a programmable data processing apparatus, and/or other devices to function in a particular manner, such that the computer readable storage medium having instructions stored therein comprises an article of manufacture including instructions which implement aspects of the function/act specified in the flowchart and/or block diagram block or blocks.

[0238] The computer readable and executable instructions may also be loaded onto a computer, other programmable data processing apparatus, or other device to cause a series of operational steps to be performed on the computer, other programmable apparatus or other device to produce a computer implemented process, such that the instructions which execute on the computer, other programmable apparatus, or other device implement the functions/acts specified in the flowchart and/or block diagram block or blocks.

[0239] In the discussion, unless otherwise stated, adjectives such as “substantially” and “about” that modify a condition or relationship characteristic of a feature or features of an embodiment of the invention, are to be understood to mean that the condition or characteristic is defined to within tolerances that are acceptable for operation of the embodiment for an application for which it is intended.

[0240] “Coupled with” means indirectly or directly “coupled with”.

[0241] It is important to note that the method may include is not limited to those diagrams or to the corresponding descriptions. For example, the method may include additional or even fewer processes or operations in comparison to what is described in the figures. In addition, embodiments of the method are not necessarily limited to the chronological order as illustrated and described herein.

[0242] Discussions herein utilizing terms such as, for example, “processing”, “computing”, “calculating”, “determining”, “establishing”, “analyzing”, “checking”, “estimating”, “deriving”, “selecting”, “inferring” or the like, may refer to operation(s) and/or process(es) of a computer, a computing platform, a computing system, or other electronic computing device, that manipulate and/or transform data represented as physical (e.g., electronic) quantities within the computer’s registers and/or memories into other data similarly represented as physical quantities within the computer’s registers and/or memories or other information storage medium that may store instructions to perform operations and/or processes. The term determining may, where applicable, also refer to “heuristically determining”.

[0243] It should be noted that where an embodiment refers to a condition of “above a threshold”, this should not be construed as excluding an embodiment referring to a condition of “equal or above a threshold”. Analogously, where an embodiment refers to a condition “below a threshold”, this should not to be construed as excluding an embodiment referring to a condition “equal or below a threshold”. It is clear that should a condition be interpreted as being fulfilled if the value of a given parameter is above a threshold, then the same condition is considered as not being fulfilled if the value of the given parameter is equal or below the given threshold. Conversely, should a condition be interpreted as being fulfilled if the value of a given parameter is equal or above a threshold, then the same condition is considered as not being fulfilled if the value of the given parameter is below (and only below) the given threshold.

[0244] It should be understood that where the claims or specification refer to “a” or “an” element and/or feature, such reference is not to be construed as there being only one of that element. Hence, reference to “an element” or “at least one element” for instance may also encompass “one or more elements”.

[0245] Terms used in the singular shall also include the plural, except where expressly otherwise stated or where the context otherwise requires.

[0246] In the description and claims of the present application, each of the verbs, “comprise” “include” and “have”, and conjugates thereof, are used to indicate that the object or objects of the verb are not necessarily a complete listing of components, elements or parts of the subject or subjects of the verb.

[0247] Unless otherwise stated, the use of the expression “and/or” between the last two members of a list of options for selection indicates that a selection of one or more of the listed options is appropriate and may be made, and may be used interchangeably with the expressions “at least one of the following”, “any one of the following” or “one or more of the following”, followed by the list of options.

[0248] It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments or example, may also be provided in combination in a single embodiment. Conversely, various features of the invention, which are, for brevity, described in the context of a single embodiment, example and/or option, may also be provided separately or in any suitable sub-combination or as suitable in any other described embodiment, example or option of the invention. Certain features described in the context of various embodiments, examples and/or optional implementation are not to be considered essential features of those embodiments, unless the embodiment, example and/or optional implementation is inoperative without those elements.

[0249] It is noted that the term “exemplary” is used herein to refer to examples of embodiments and/or implementations, and is not meant to necessarily convey a more-desirable use-case.

[0250] The number of elements shown in the Figures should by no means be construed as limiting and is for illustrative purposes only.

[0251] As used herein, if a machine (e.g., a processor) is described as “configured to” “operable to” perform a task (e.g., configured to cause application of a predetermined field pattern), then, at least in some embodiments, the machine may include components, parts, or aspects (e.g., software) that enable the machine to perform a particular task. In some embodiments, the machine may perform this task during operation. Similarly, when a task is described as being done “in order to” establish a target result (e.g., in order to apply a plurality of electromagnetic field patterns to the object), then, at least in some embodiments, carrying out the task may accomplish the target result.

[0252] Throughout this application, various embodiments may be presented in and/or relate to a range format. It should be understood that the description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the embodiments. Accordingly, the description of a range should be considered to have specifically disclosed all the possible subranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed subranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the range.

[0253] Where applicable, whenever a numerical range is indicated herein, it is meant to include any cited numeral (fractional or integral) within the indicated range.

[0254] The phrases “ranging/ranges between” a first indicate number and a second indicate number and “ranging/ranges from” a first indicate number “to” a second indicate number are used herein interchangeably and are meant to include the first and second indicated numbers and all the fractional and integral numerals there between.

[0255] While the invention has been described with respect to a limited number of embodiments, these should not be construed as limitations on the scope of the invention, but rather as exemplifications of some of the embodiments.

CLAIMS

What is claimed is:

1. A method for providing information to a user of a vehicle via a display device that is worn by the user, the method comprising:

providing a vehicle coordinate system (**V_{xyz}**) representing the principle axes rotation of the vehicle for defining a vehicle orientation relative to a world coordinate system (**W_{xyz}**) of a reference world space;

providing at least one display device coordinate system (**D_{xyz}**) that defines a display device orientation relative to the vehicle coordinate system (**Vxyz**), wherein the display device is operable to visually display to the user at least one first symbol; and

providing a symbol coordinate system (**S_{xyz}**) that is spatially fixed with the at least one first symbol to be displayed on the display device and that defines three symbol rotation axes that are orthogonal to each other;

spatially fixing at least one of the symbol rotation axes (**S_{α}**) to a vehicle principal axis of rotation descriptive of an orientation of the vehicle; and

wherein at least one further symbol rotation axis (**S_{β}**) is correspondingly selectively spatially fixable to one of:

at least one other principal axis of rotation of the vehicle; and

at least one display rotation axis of the display device coordinate system.

2. The method of claim 1, comprising translationally adjusting a position of the displayed at least one first symbol in accordance with a vehicle state vector.

3. The method of claim 2, wherein the vehicle state vector pertains to one or more of the following: a flight path vector; and engine thrust direction and/or magnitude thereof.

4. The method of claim 3, comprising selectively displaying a symbol of the at least one first symbol that represents the vehicle state vector, in one of the following display modes:

in a first, regular display mode, as long as the symbol representing the vehicle state vector can be displayed to the user by the display device in a directionally conformable manner within a given field of view; and

in a second, ghosted display mode, if the symbol representing the vehicle state vector cannot be displayed by the display device in a directionally conformable manner within the given field of view.

5. The method of any one of the preceding claims, wherein the providing of the symbol coordinate system (**S_{xyz}**) on the display device is operable at all and any orientation of the symbol coordinate system (**S_{xyz}**) relative to vehicle coordinate system (**V_{xyz}**).

6. The method of any one of the preceding claims,

wherein the at least one of the symbol rotation axes (**S_{α}**) is a roll orientation that is spatially fixed, correspondingly, to the roll orientation of the vehicle coordinate system (**V_{xyz}**); and

wherein the at least one further symbol rotation axis (**S_{β}**) is a pitch and/or yaw orientation of the symbol coordinate system (**S_{xyz}**) that is spatially fixed, correspondingly, to a pitch and/or yaw orientation of the display device coordinate system (**D**$_{xyz}$) relative to the vehicle coordinate system (**V**$_{xyz}$).

7. The method of any of the preceding claims, further comprising:

providing a pointer symbol coordinate system (**P**$_{xyz}$) that is spatially associated with a pointer symbol to be displayed on the display device and that defines at least two pointer symbol translational axes (y-z) that are orthogonal to each other.

8. The method of claim 7, further comprising:

determining a first current gaze direction of the user; and

displaying on the display device the pointer symbol concurrently with the at least one first symbol, wherein the pointer symbol indicates the first current gaze direction of the user.

9. The method of any one of the preceding claims, wherein the displayed at least one first symbol comprises a user interface object that is selectively actionably engageable by the user.

10. The method of any of the claims 8 or 9, further comprising:

tracking gaze of the user;

determining if a gaze-based object selection criterion is met; and

if the gaze-based object selection criterion is met, providing the user with information indicating that the gaze-based object selection criterion is met.

11. The method of claim 10, further comprising:

determining if an actionable engagement criterion is met for actionably engaging a virtual object that is associated with the selected user interface object.

12. The method of claim 11, wherein the selection criterion refers to any one of the following:

a dwell time of the first current gaze direction within a predetermined interval; and/or

a physical action performed by the user.

13. The method of claim 7, comprising:

determining a second current gaze direction of the user;

determining a second difference value between the second current gaze direction and at least one virtual gaze direction; and

if the second difference value exceeds a second difference threshold, spatially fixing the at least one further symbol rotation axis (**S_β**) of the symbol coordinate system (**S_{xyz}**) to the display device coordinate system (**D_{xyz}**).

14. The method of claim 13, further comprising:

spatially fixing the at least one of the symbol rotation axes (**S_α**) to the display device coordinate system (**D_{xyz}**).

15. The method of claim 13 or 14, further comprising displaying at least one second symbol in correspondence with and instead of the at least one first symbol.

16. The method of claim 15, further comprising:

determining a third difference value between a third current gaze direction and the at least one virtual gaze direction; and

if the third difference value is below a third difference threshold value:

spatially fixing, at least one of the symbol rotation axes (**S_α**) to at least one of the axes of the vehicle coordinate system (**V_{xyz}**) for displaying the at least one first symbol.

17. The method of any one of the preceding claims, wherein the at least one symbol relates to any one of the following:

a non-conformal symbol; and

a conformal symbol;

wherein the conformal symbol relates to any one of the following:

a fully conformal symbol; and

a partially conformal symbol.

18. The method of claim 17, wherein a symbol that is displayed in a conformal manner can be adapted to be displayed in a manner to suit a non-conformal representation setting, and vice versa.

19. The method of any one of claims 17 or 18, wherein the non-conformal symbol is descriptive of any one of the following:

a value relating to a parameter describable by a scalar; ordinal; categorical; and/or interval parameter.

20. The method of any one of claims claim 17 to 19, wherein the non-conformal symbol comprises user-selectable values.

21. A method for providing a user with information about a remotely operated vehicle via one or more display devices of a remote control station which is located remotely from the remotely operated vehicle, the one or more display devices comprising a head-mounted display (HMD) device, the method comprising:

providing a vehicle coordinate system (**V_{xyz}**) that defines an orientation of the remotely operated vehicle relative to a world coordinate system (**W_{xyz}**) of a reference world space;

providing an HMD device coordinate system (**D_{xyz}**) defining an orientation of the HMD device relative to the remote control station*;*

conveying to the user, by the one or more display devices comprising the HMD device, a digital image of an emulated view of the exterior of the remotely operated vehicle from a perspective of the remotely operated vehicle;

providing a symbol coordinate system (**S_{xyz}**) that is spatially associated with a symbol to be displayed by the HMD device, wherein the symbol phical coordinate system (**S_{xyz}**) defines three symbol rotation axes that are orthogonal to each other;

spatially fixing at least one of the symbol rotation axes (**S_{α}**) to a principal axis of rotation of the remotely operated vehicle; and

selectively spatially fixing at least one further symbol rotation axis (**S_{β}**) to one of:

at least one other principal axis of rotation of the remotely operated vehicle; and

at least one principal rotation axis of the HMD coordinate system (**D_{xyz}**).

22. The method of claim 21, wherein the one or more display devices further comprise a non-wearable display device which is stationary with respect to the remote control station.

23. The method of claim 21 or claim 22, wherein the remote control station is orientationally fixed to one of the following:

the reference world space;

the vehicle coordinate system (**V_{xyz}**) of the remotely operated vehicle; and

a control station carrier platform which is movable relative to the reference world space and which comprises the remote control station.

24. The method of claim 23, wherein the control station carrier platform comprises one of the following: a command and control aircraft; a naval vessel ship; and a motion platform assembly.

25. A method for generating and displaying by a display device that is worn by a user located in a control station, a symbol that is operatively associated with an operation function of a vehicle, the method comprising:

determining a first gaze direction of the user;

determining a first difference value between the first gaze direction and a first virtual gaze direction towards a real-world control object comprised in the control station and associated with a vehicle operation function;

determining, while the first difference value is within a predetermined interval for a certain time period, if a gaze-based object selection criterion is met; and

displaying by the display device a symbol that is operatively associated with the vehicle operation function relating to the real-world control object, if the gaze-based object selection criterion is met.

26. The method of claim 25, further comprising:

determining a second difference value between a second gaze direction and a second virtual gaze direction towards a field-of-view (FOV) region of another real-world control object of the vehicle; and

spatially fixing at least one of the symbol rotation axes (**S_α**) associated with the symbol, correspondingly, to at least one of the axes of a vehicle coordinate system (**V_{xyz}**) defining an orientation of the vehicle relative to a reference world space, if the second difference value meets an object-handoff criterion.

27. The method of claim 26, further comprising:

spatially fixing at least one further symbol rotation axis (**S_β**) to one of: at least one other principal axis of rotation of the vehicle; and

at least one display rotation axis of a display device coordinate system (**D_{xyz}**) defining an orientation of the display device relative to the vehicle.

28. The method of claims 26 or 27, wherein the object-handoff criterion refers to any one of the following:

a dwell time during which the second difference value is within a predetermined interval; and/or

a physical action performed by the user.

29. The method of any one of the claims 26 to 28, further comprising:

determining a third difference value between a third gaze direction and a third virtual gaze direction towards the displayed symbol; and

providing the user with information indicative of a difference between the third gaze direction and the third virtual gaze direction towards the displayed symbol, if a third level difference value is within a predetermined interval for at least a certain time period.

30. The method of claims 29, further comprising:

determining if an object selection criterion is met for selecting the displayed symbol.

31. The method of claim 30 wherein the selection criterion refers to any one of the following:

a dwell time of the third gaze direction within the predetermined interval; and/or

a physical action performed by the user.

32. The method of any one of claims 30 or 31, wherein, if the selection criterion is met, an operational state of the vehicle can be altered responsive to actionably engaging the symbol.

33. The method of claim 32, wherein actionably engaging the symbol comprises engaging another control that is operatively associated with the displayed symbol for controlling a corresponding vehicle operation function.

34. The method of claim 33, wherein the other control comprises a rotary control knob requiring a multiple-step actuation sequence to prevent accidentally actionably engaging the displayed symbol.

35. The method of claims 34, wherein the rotary control knob comprises a push button rotary knob.

36. The method of any one claims 25 to 35, wherein the vehicle operation function pertains to displaying information about an operational state of the vehicle and/or vital signs of the user.

37. The method of any one of claims 25 to 36, wherein the displayed symbol can be selectively operatively associated with different operating functions of the vehicle.

38. A method for controlling a vehicle by a user, the method comprising:

displaying, by a display device worn by the user, a plurality of selectable non-conformal symbols which are associated with a respective plurality of vehicle operation functions; and

if a selection criterion is met, selecting a symbol of a plurality of symbols for allowing actionably engaging the selected symbol by the user.

39. The method of claim 38, further comprising actionably engaging the symbol if an actionable engagement criterion is met.

40. The method of claims 38 or 39, wherein selecting and/or actionably engaging the symbol comprises physically engaging a control.

41. The method of claim 40, wherein the control is one-handed operable by the user.

42. The method of claims 40 or 41, wherein the control comprises a push button rotary control knob assembly that is consolidated in a single control knob.

43. A gaze tracking and display (GTAD) system operable to provide information to a user of a vehicle via a display device that is worn by the user, the system comprising:

one or more processors; and

one or more memories storing software code portions executable by the one or more processors to cause the GTAD system to perform the following steps:

providing a vehicle coordinate system (**V_{xyz}**) that defines a vehicle orientation relative to a world coordinate system (**W_{xyz}**) of a reference world space;

providing at least one display device coordinate system (**D_{xyz}**) that defines a display device orientation relative to the vehicle coordinate system, wherein the display device is operable to visually display to the user at least one first symbol; and

providing a symbol coordinate system (**S_{xyz}**) that is spatially fixed with the at least one first symbol to be displayed on the display device and that defines three symbol rotation axes that are orthogonal to each other;

spatially fixing, during the display of the at least one first symbol, at least one of the symbol rotation axes (**S_{α}**) to a vehicle principal axis of rotation descriptive of an orientation of the vehicle.

44. The GTAD system of claim 43, during the display of the at least one first symbol, at least one further symbol rotation axis (**S_{β}**) is correspondingly selectively spatially fixable to one of:

at least one other principal axis of rotation of the vehicle; and

at least one display rotation axis of the display device coordinate system.

45. A computer program product operable to provide information to a user of a vehicle via a display device that is worn by the user, the computer program product comprising a non-transitory tangible storage medium and/or a transitory storage medium readable by one or more processing circuits and storing instructions for execution by the one or more processing circuit for performing a method comprising:

providing a vehicle coordinate system (**V_{xyz}**) that defines a vehicle orientation relative to a world coordinate system (**W_{xyz}**) of a reference world space;

providing a display device coordinate system (**D_{xyz}**) that defines a display device orientation relative to the vehicle coordinate system, wherein the display device is operable to visually display to the user at least one first symbol; and

providing a symbol coordinate system (**S_{xyz}**) that is spatially fixed with at least one first symbol to be displayed on the display device and that defines three symbol rotation axes that are orthogonal to each other;

spatially fixing at least one of the symbol rotation axes (**S_α**) to a vehicle principal axis of rotation descriptive of an orientation of the vehicle; and

wherein at least one further symbol rotation axis (**S_β**) is correspondingly selectively spatially fixable to one of:

at least one other principal axis of rotation of the vehicle; and

at least one display rotation axis of the display device coordinate system (**Dxyz**).

46. A gaze tracking and display (GTAD) system operable to provide information to a user of a vehicle via a display device that is worn by the user, the GTAD system comprising:

a gaze tracker subsystem of a control station for controlling a vehicle, the gaze tracker subsystem comprising station gaze tracker components;

a wearable display device comprising display gaze tracking components;

a gaze tracker engine for tracking gaze of the user wearing the wearable display device, wherein the gaze of the user is tracked based on information provided by the gaze tracker subsystem and the wearable display device; and

a symbology rendering engine for causing display of at least one first symbol to the user via the wearable display device;

wherein, a symbol coordinate system (**S_{xyz}**) is spatially fixed with the at least one first symbol and defines three symbol rotation axes that are orthogonal to each other;

wherein during the display of the at least one first symbol and the tracking of the user's gaze, at least one of the symbol rotation axes (**S_{α}**) is spatially fixed by the symbology rendering engine to a vehicle principal axis of rotation descriptive of an orientation of the vehicle.

47. The GTAD system of claim 46, wherein at least one further symbol rotation axis (**S_{β}**) is correspondingly selectively spatially fixed or fixable by the symbology rendering engine to one of:

at least one other principal axis of rotation of the vehicle; and

at least one display rotation axis of a display device coordinate system (**Dxyz**).

48. A computer program product directly loadable into an internal memory of a digital computer, the computer program product comprising software code portions for performing the steps of any one of the claims 1 to 42 when the computer program product is run on a computer.

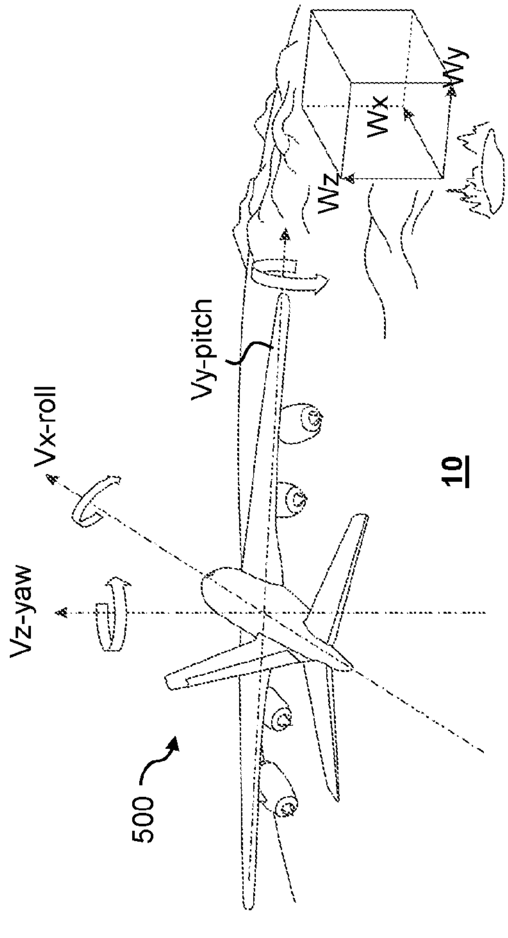
500
Vz-yaw
Vx-roll
Vy-pitch
10
Wz
Wx
Wy

FIG. 1A

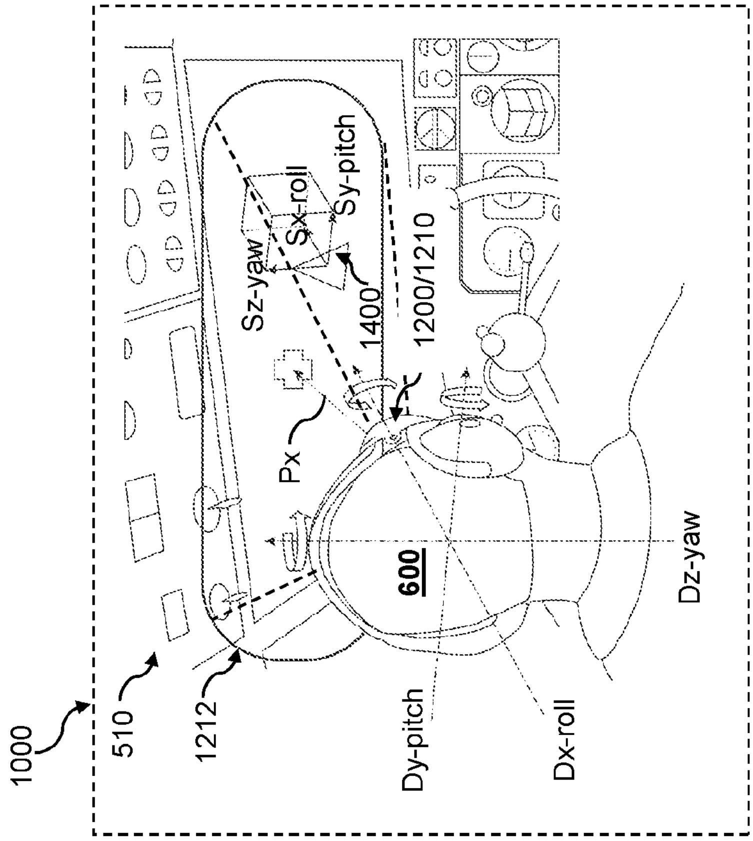
1000
510
1212
Dy-pitch
Dx-roll
Dz-yaw
600
Px
Sz-yaw
Sx-roll
Sy-pitch
1400
1200/1210

FIG. 1B

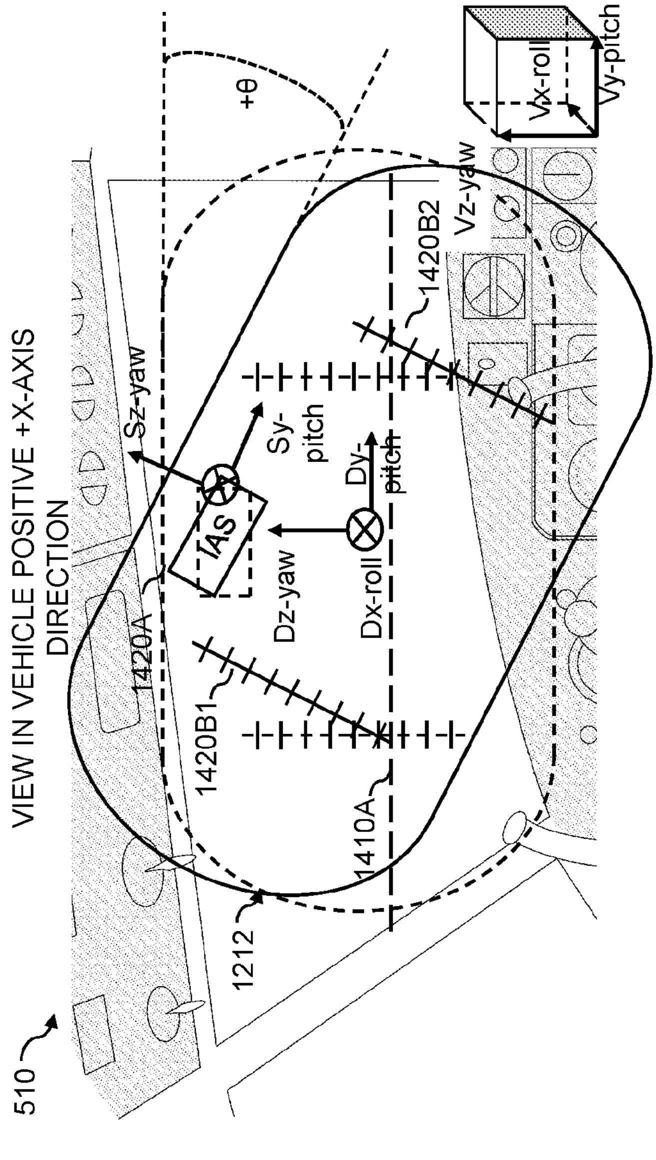
VIEW IN VEHICLE POSITIVE +X-AXIS DIRECTION
510
1212
1410A
1420B1
1420A
1420B2
Sz-yaw
Sy-
pitch
Dy-
pitch
Dz-yaw
Dx-roll
TAS
+θ
Vz-yaw
Vx-roll
Vy-pitch

FIG. 2A

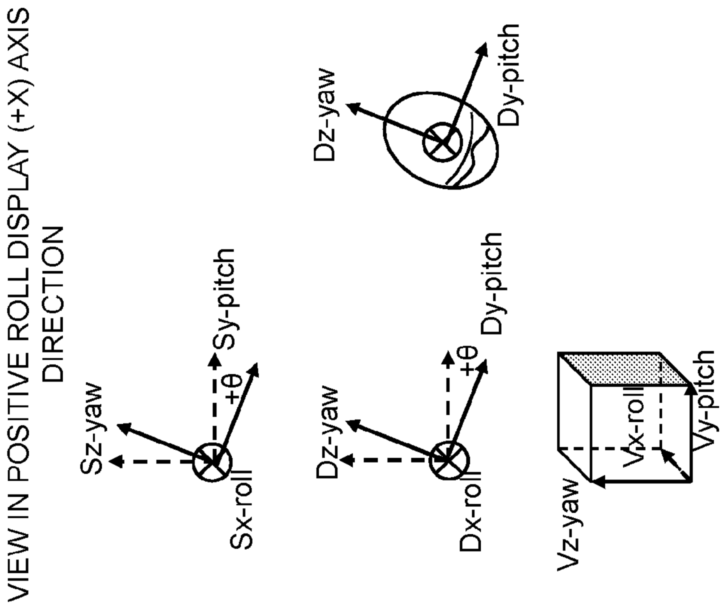
VIEW IN POSITIVE ROLL DISPLAY (+X) AXIS DIRECTION
Sz-yaw
Sx-roll
+θ
Sy-pitch
Dz-yaw
Dx-roll
+θ
Dy-pitch
Dz-yaw
Dy-pitch
Vz-yaw
Vx-roll
Vy-pitch

FIG. 2B

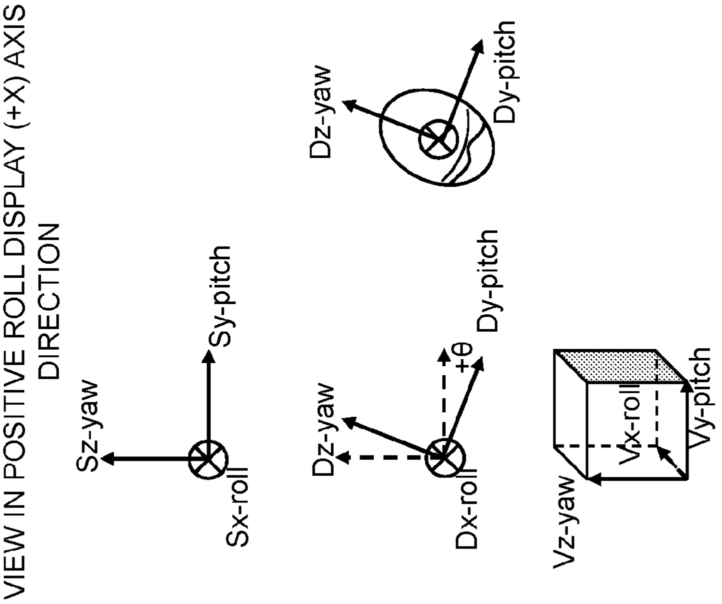
VIEW IN POSITIVE ROLL DISPLAY (+X) AXIS DIRECTION
Sz-yaw
Sy-pitch
Sx-roll
Dz-yaw
Dy-pitch
+θ
Dx-roll
Dz-yaw
Dy-pitch
Vz-yaw
Vx-roll
Vy-pitch

FIG. 3B

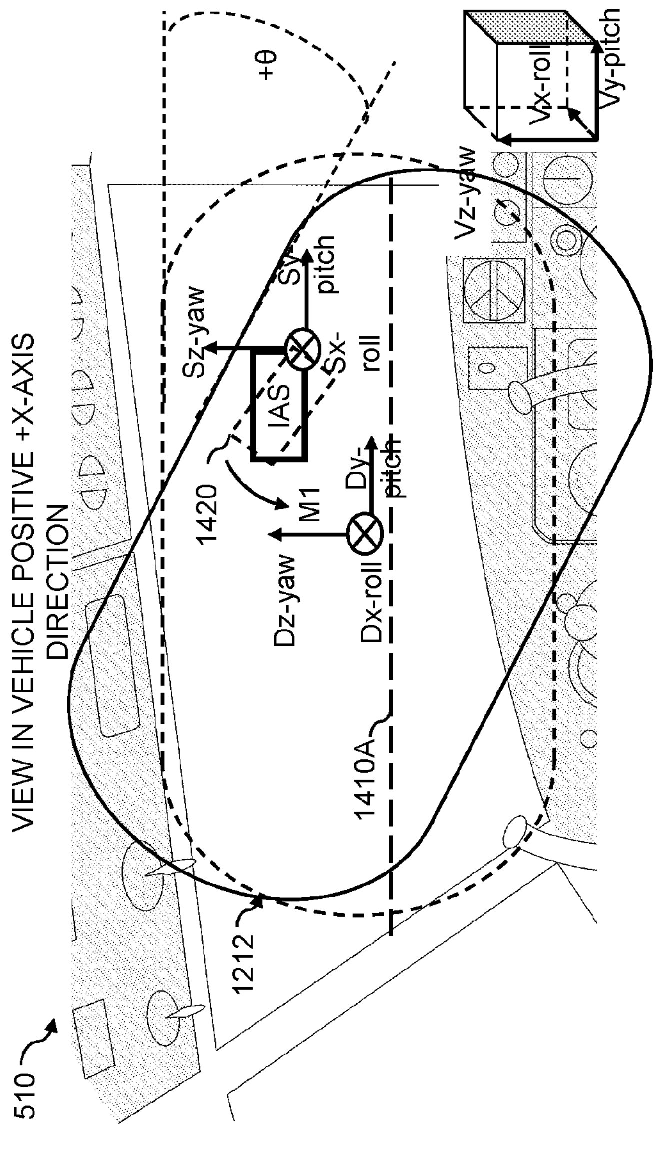
VIEW IN VEHICLE POSITIVE +X-AXIS DIRECTION
510
1212
1410A
1420
M1
IAS
Sz-yaw
Sy-pitch
Sx-roll
Dz-yaw
Dy-pitch
Dx-roll
+θ
Vz-yaw
Vx-roll
Vy-pitch

FIG. 3A

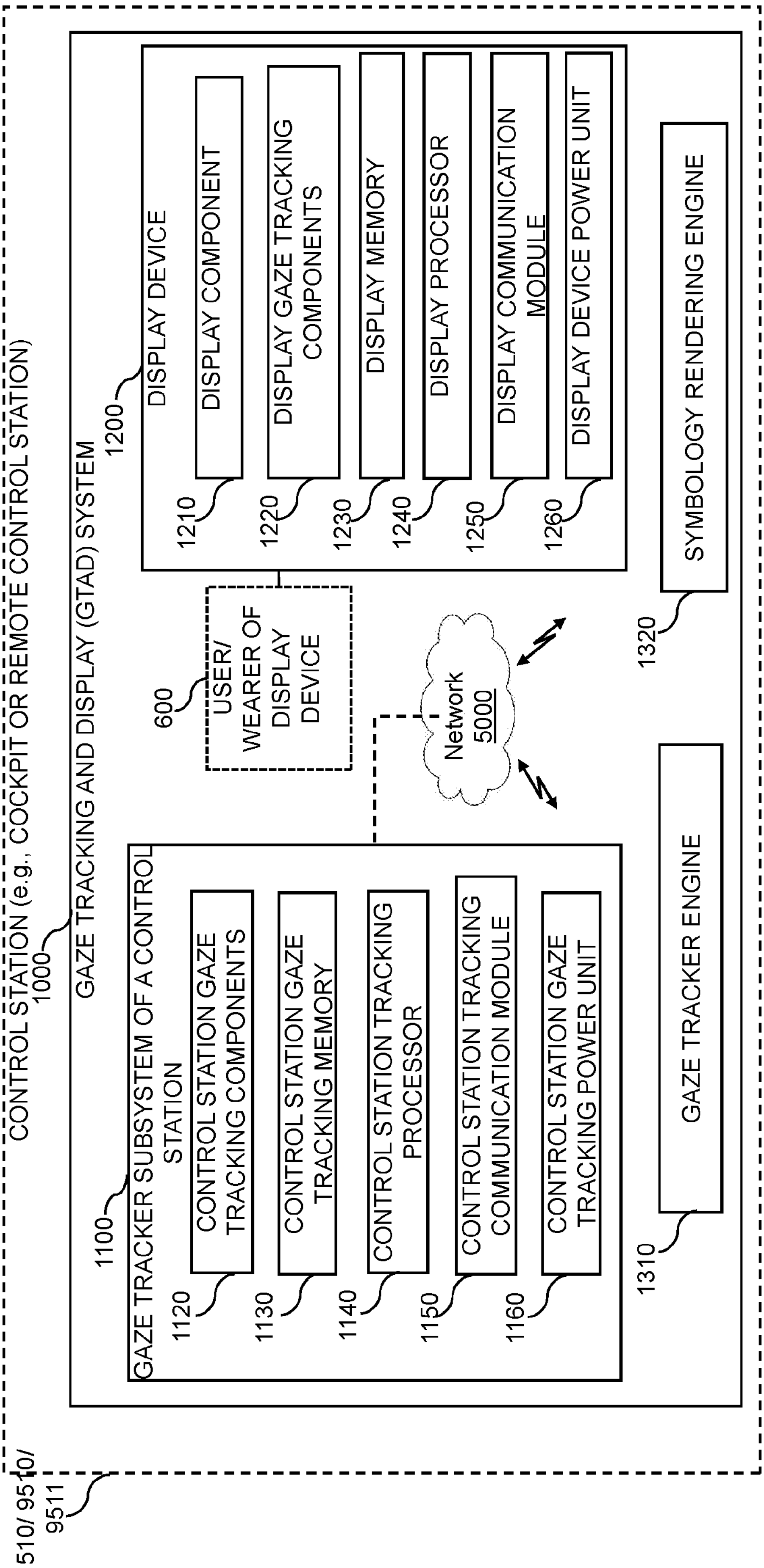
CONTROL STATION (e.g., COCKPIT OR REMOTE CONTROL STATION)
510/ 9510/ 9511
1000
GAZE TRACKING AND DISPLAY (GTAD) SYSTEM
1100
GAZE TRACKER SUBSYSTEM OF A CONTROL STATION
1120
CONTROL STATION GAZE TRACKING COMPONENTS
1130
CONTROL STATION GAZE TRACKING MEMORY
1140
CONTROL STATION TRACKING PROCESSOR
1150
CONTROL STATION TRACKING COMMUNICATION MODULE
1160
CONTROL STATION GAZE TRACKING POWER UNIT
600
USER/ WEARER OF DISPLAY DEVICE
Network
5000
1200
DISPLAY DEVICE
1210
DISPLAY COMPONENT
1220
DISPLAY GAZE TRACKING COMPONENTS
1230
DISPLAY MEMORY
1240
DISPLAY PROCESSOR
1250
DISPLAY COMMUNICATION MODULE
1260
DISPLAY DEVICE POWER UNIT
1310
GAZE TRACKER ENGINE
1320
SYMBOLOGY RENDERING ENGINE

FIG. 4

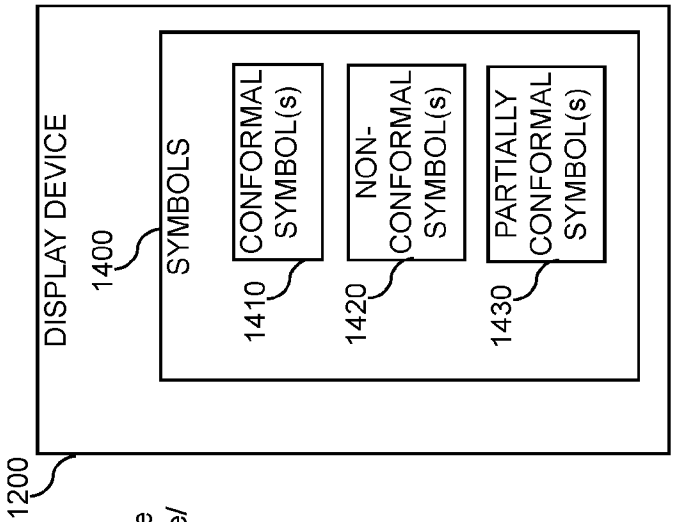
DISPLAY DEVICE
1200
1400
SYMBOLS
1410
CONFORMAL SYMBOL(s)
1420
NON-CONFORMAL SYMBOL(s)
1430
PARTIALLY CONFORMAL SYMBOL(s)

FIG. 5B

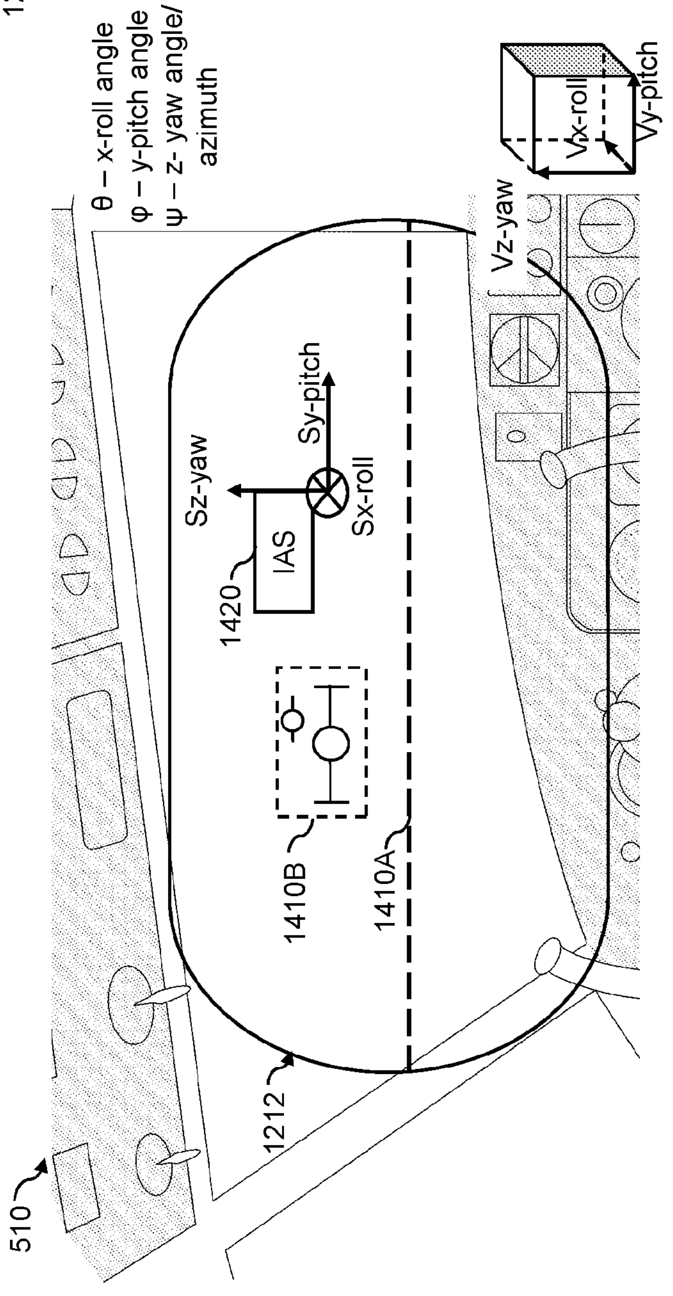
θ – x-roll angle
φ – y-pitch angle
ψ – z- yaw angle/ azimuth
Vx-roll
Vy-pitch
Vz-yaw
Sz-yaw
Sy-pitch
Sx-roll
IAS
1420
1410B
1410A
1212
510

FIG. 5A

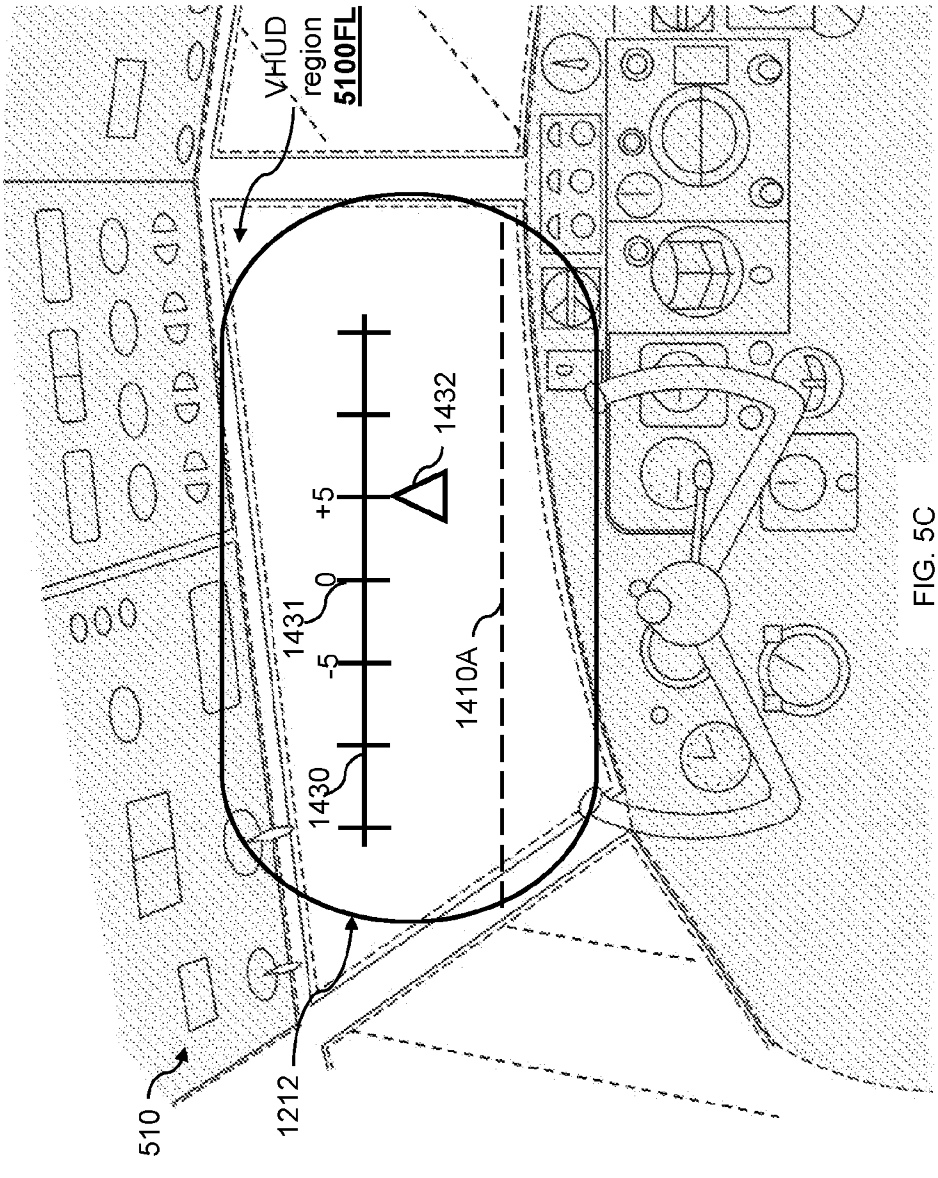

FIG. 5C

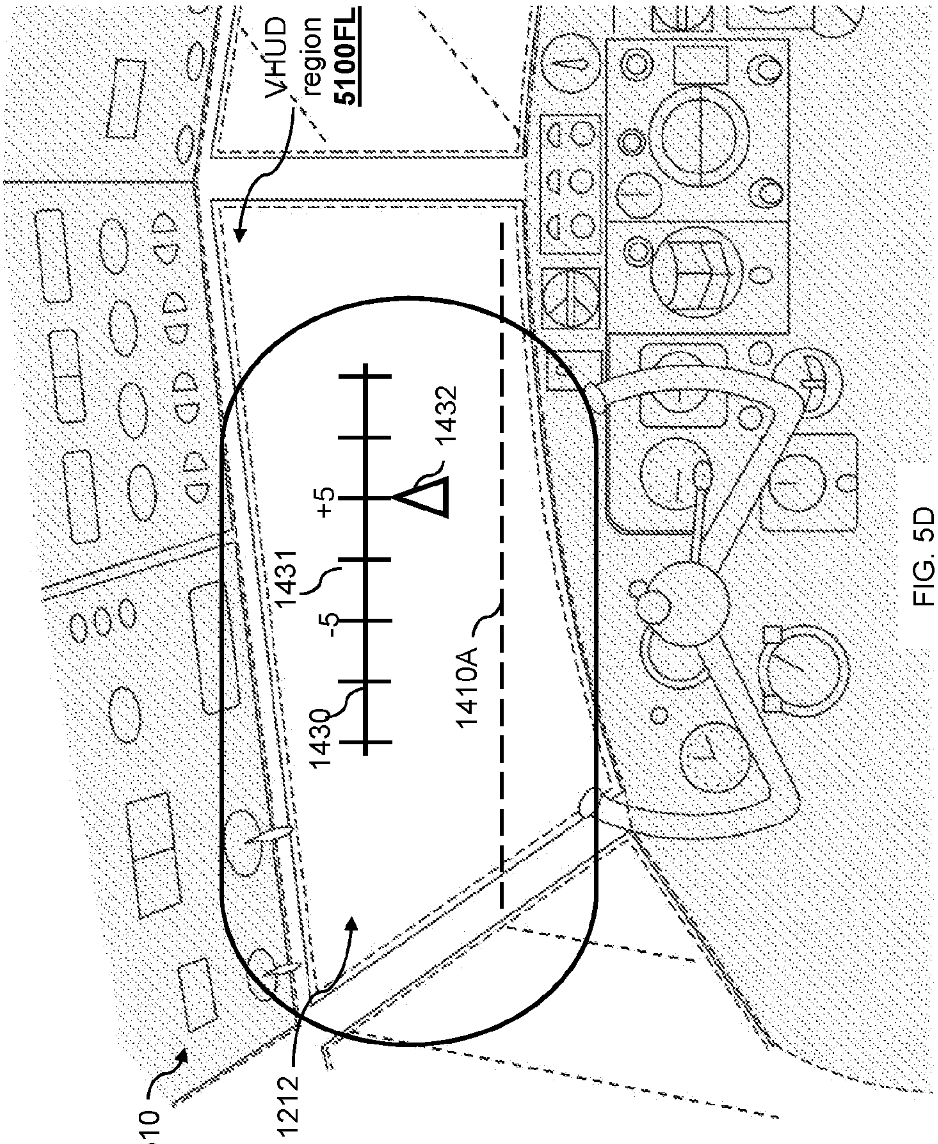

FIG. 5D

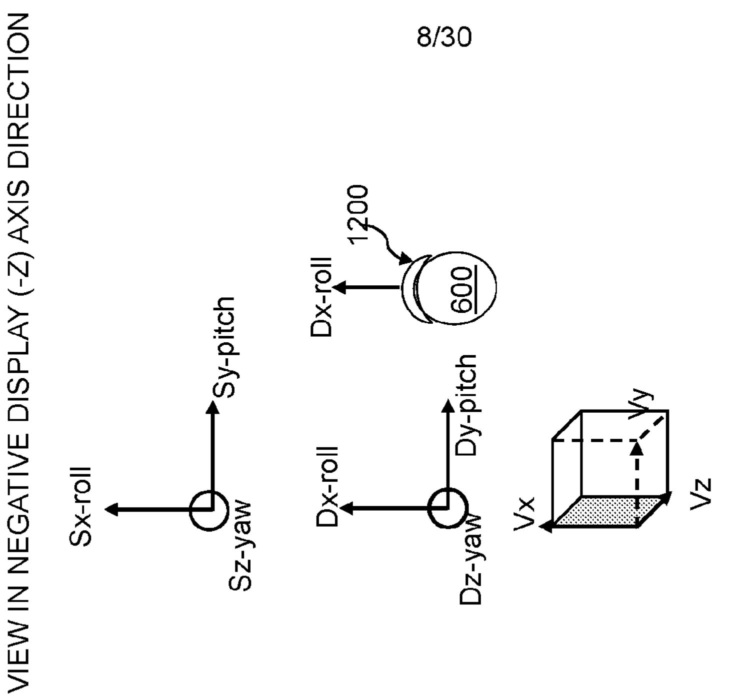
VIEW IN NEGATIVE DISPLAY (-Z) AXIS DIRECTION
Sx-roll
Sy-pitch
Sz-yaw
Dx-roll
Dy-pitch
Dz-yaw
Dx-roll
1200
600
Vx
Vy
Vz

FIG. 6B

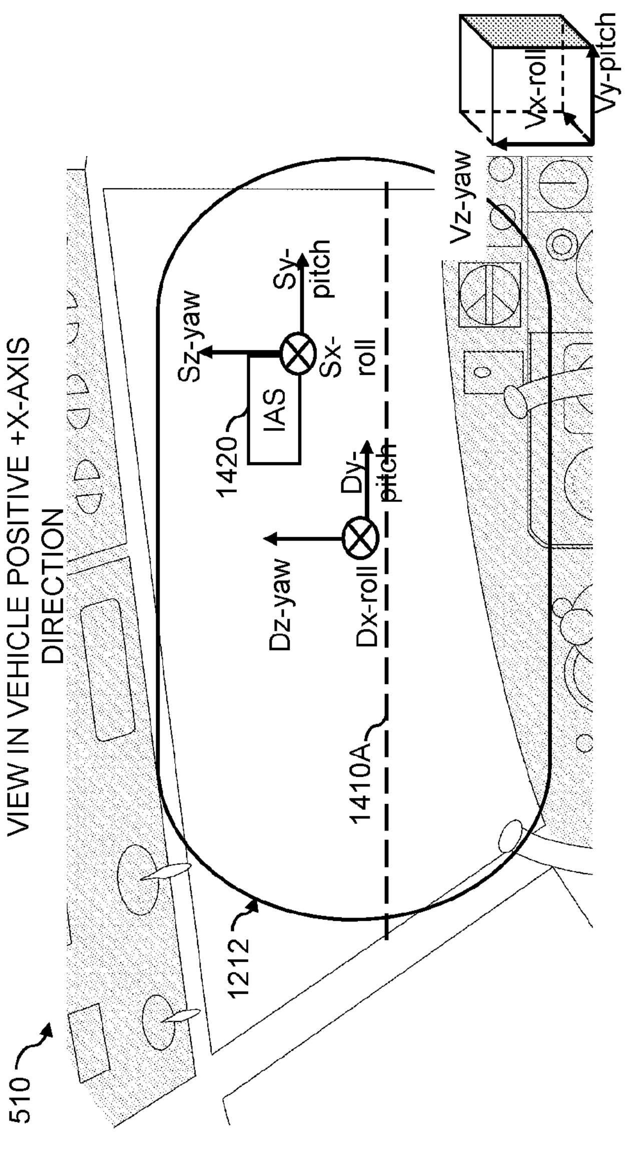
VIEW IN VEHICLE POSITIVE +X-AXIS DIRECTION
510
1212
1410A
1420
IAS
Sz-yaw
Sy-pitch
Sx-roll
Dz-yaw
Dy-pitch
Dx-roll
Vz-yaw
Vx-roll
Vy-pitch

FIG. 6A

VIEW IN NEGATIVE DISPLAY (-Z) AXIS DIRECTION

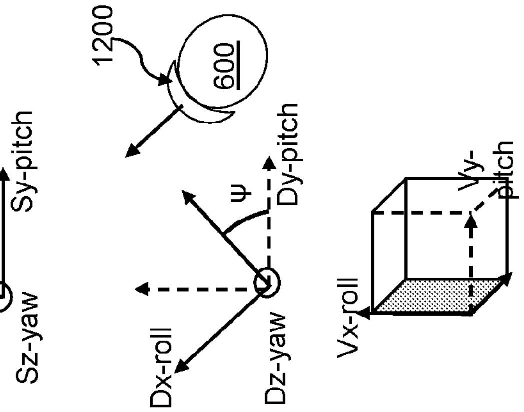

FIG. 7B

VIEW IN VEHICLE POSITIVE +X-AXIS DIRECTION

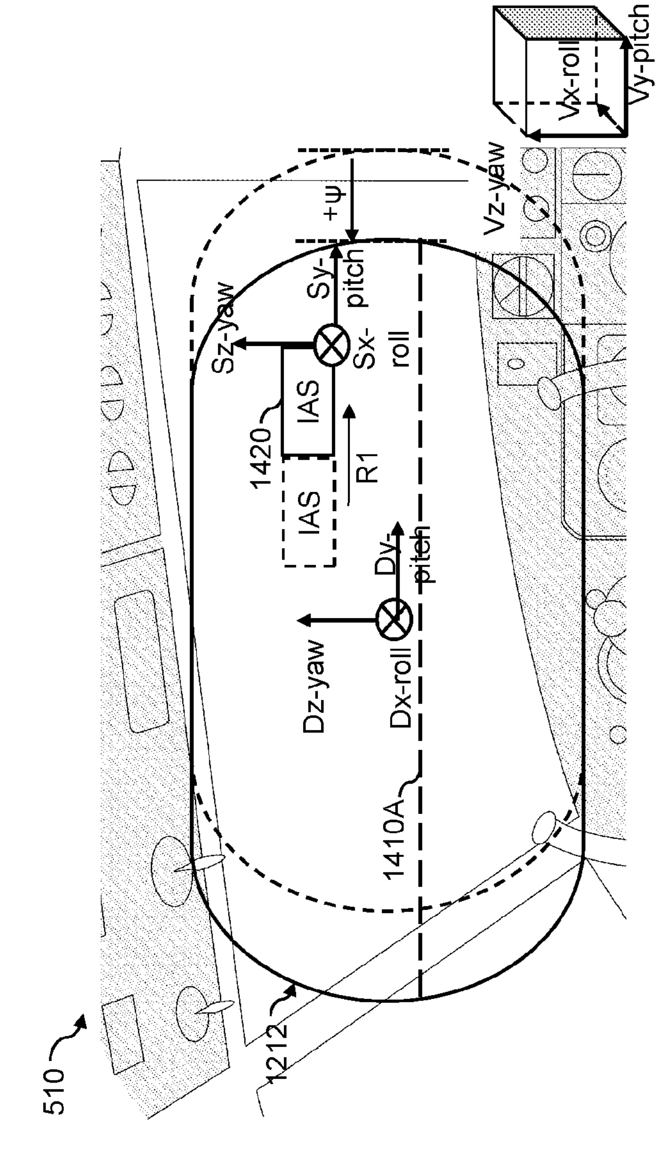

FIG. 7A

VIEW IN VEHICLE POSITIVE +X-AXIS DIRECTION

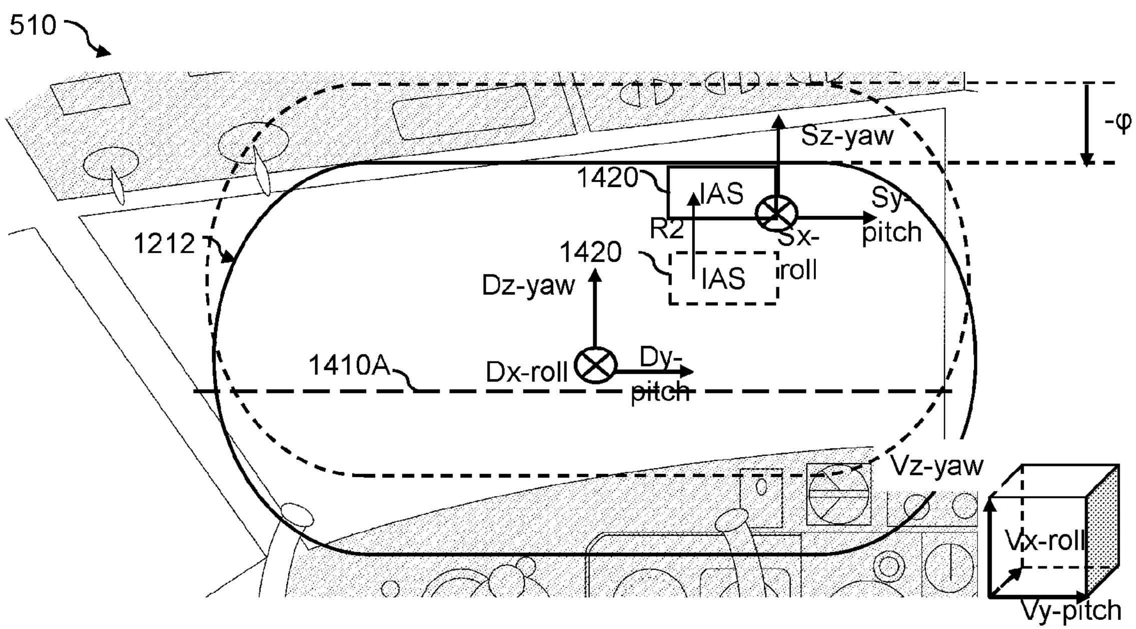

FIG. 8A

VIEW IN NEGATIVE PITCH (-Y) AXIS DIRECTION

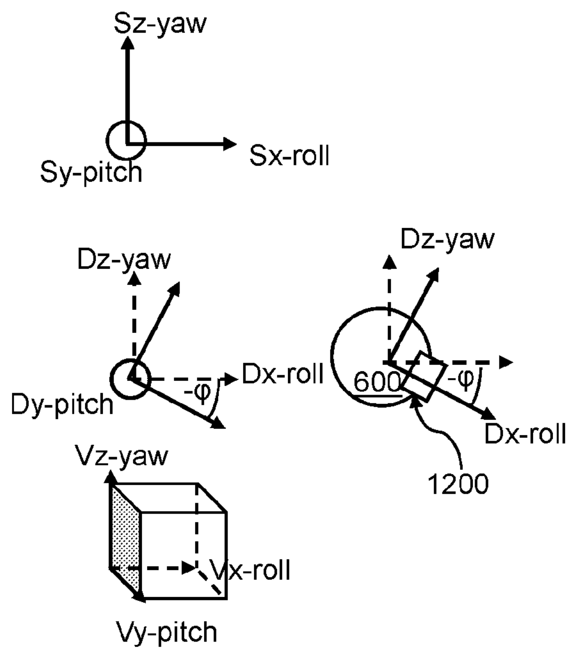

FIG. 8B

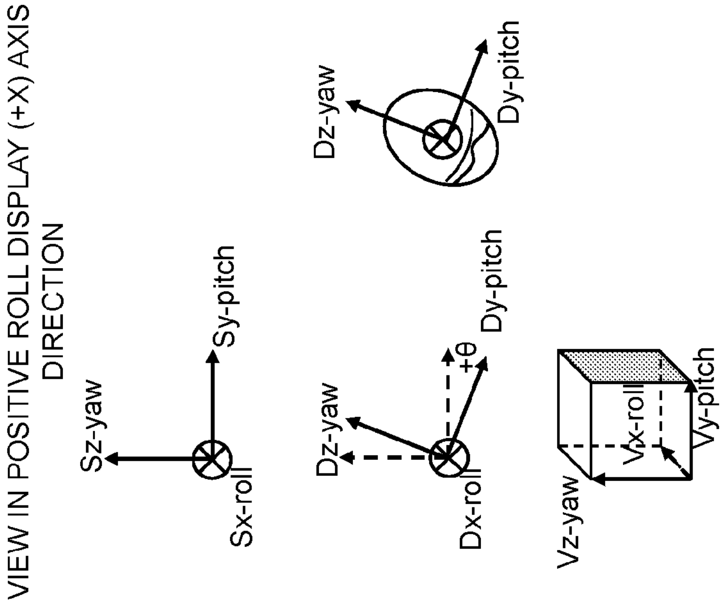
VIEW IN POSITIVE ROLL DISPLAY (+X) AXIS DIRECTION
Sz-yaw
Sy-pitch
Sx-roll
Dz-yaw
Dy-pitch
+θ
Dx-roll
Vz-yaw
Vx-roll
Vy-pitch

FIG. 9B

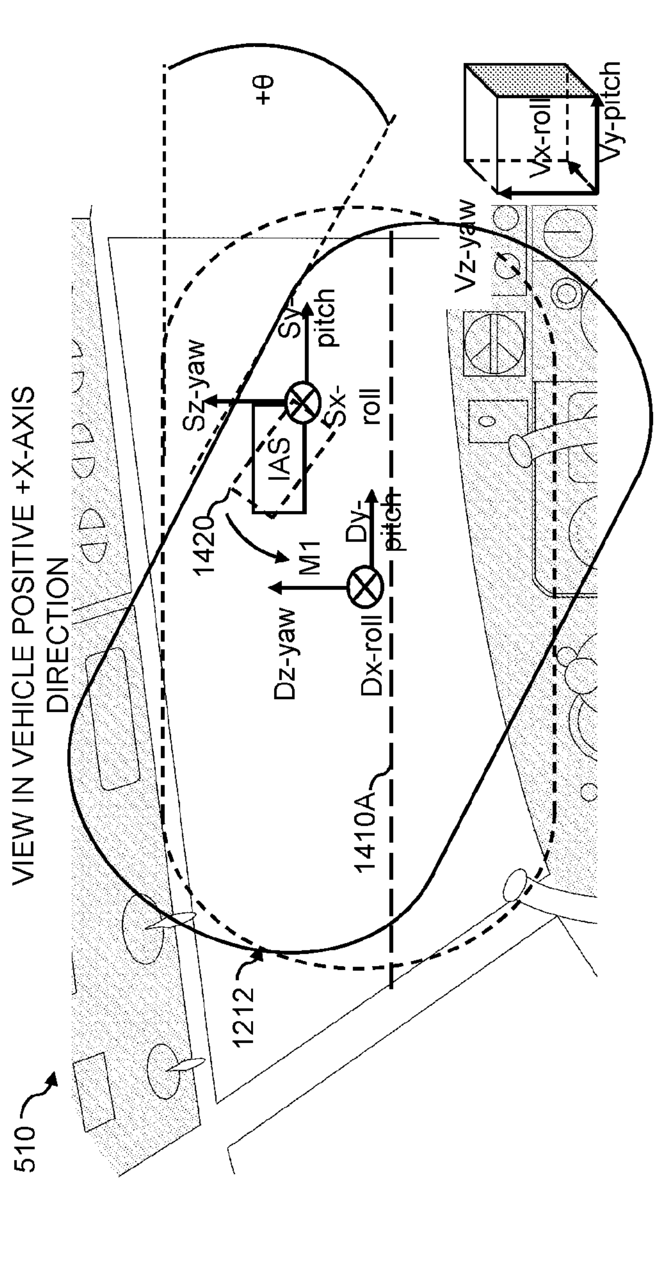
VIEW IN VEHICLE POSITIVE +X-AXIS DIRECTION
510
1212
1410A
1420
IAS
Sz-yaw
Sy-pitch
Sx-roll
M1
Dz-yaw
Dy-pitch
Dx-roll
+θ
Vz-yaw
Vx-roll
Vy-pitch

FIG. 9A

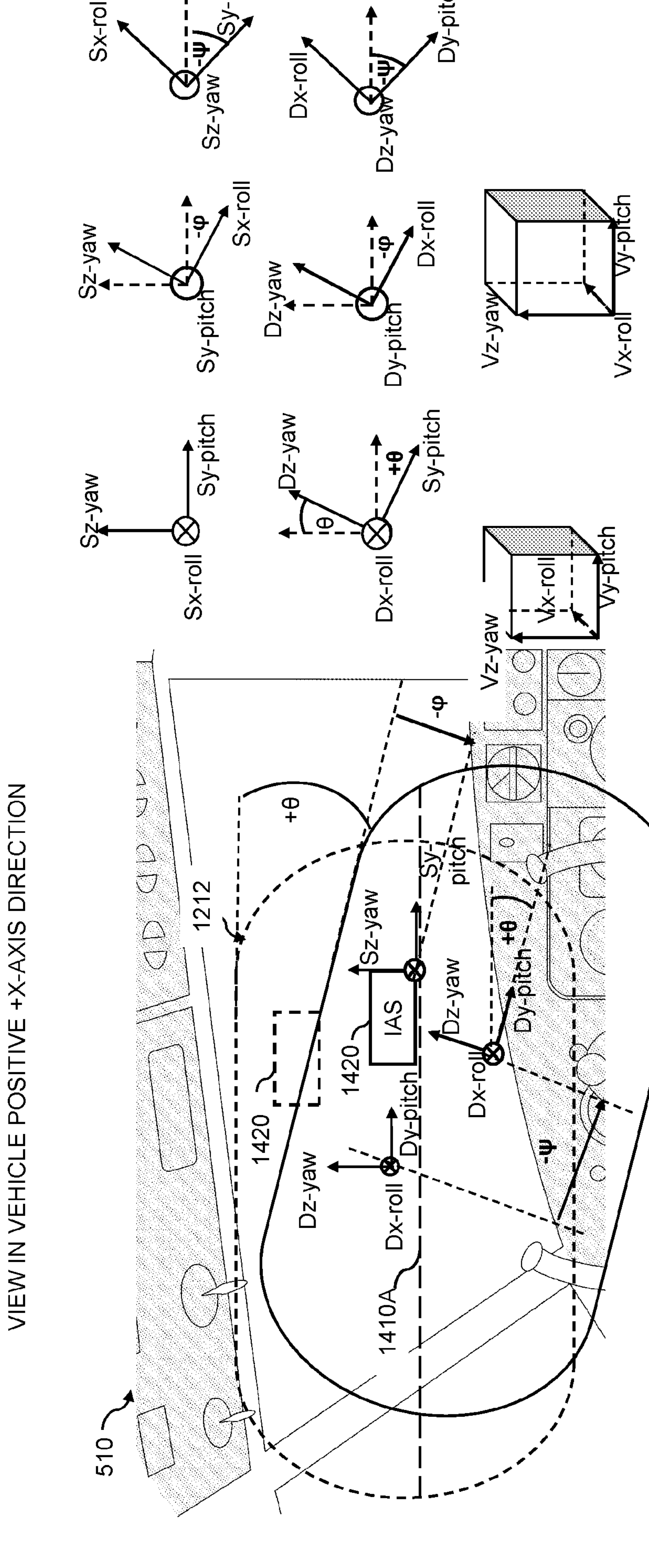

FIG. 10A

FIG. 10B

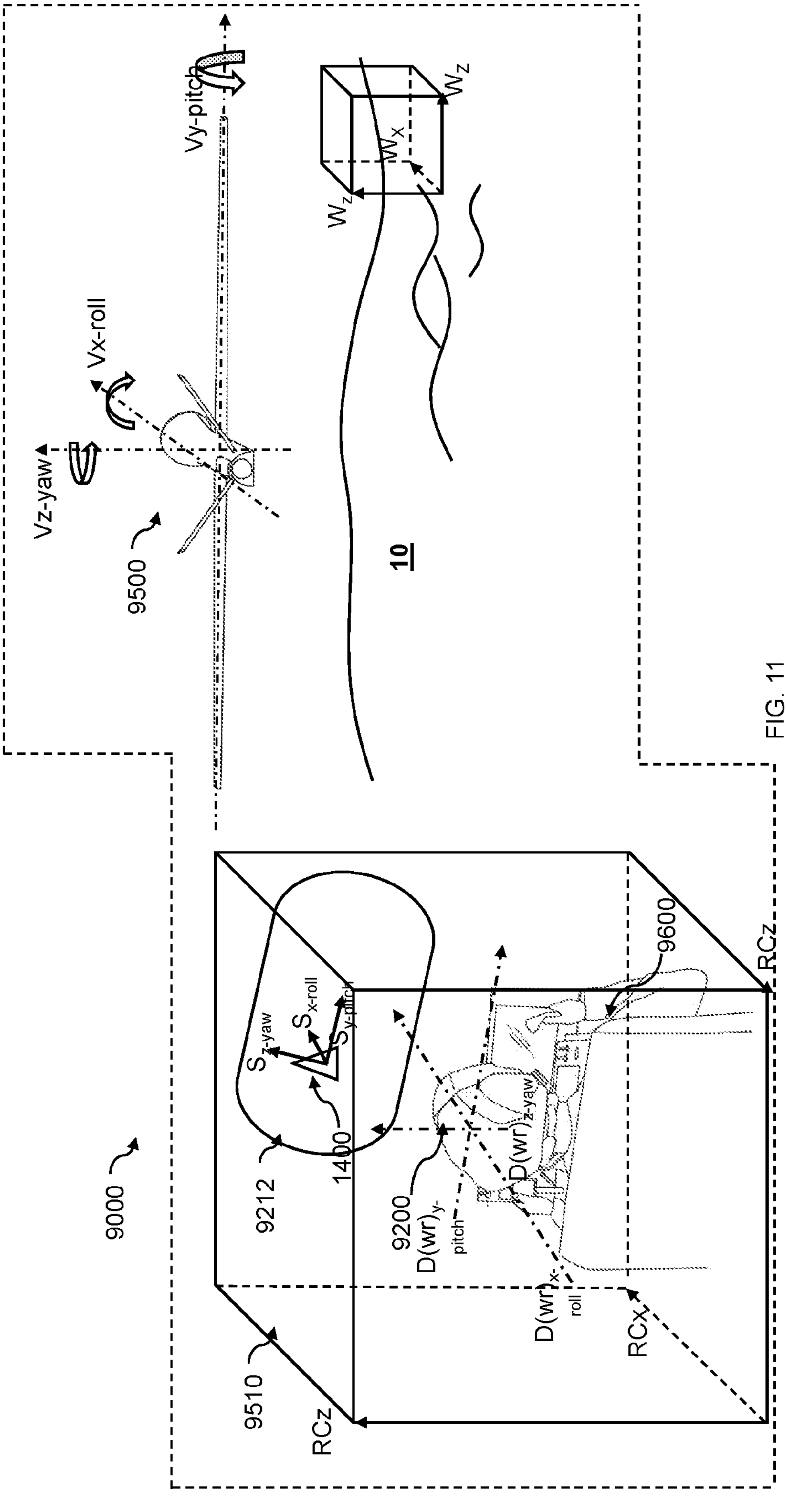
Vy-pitch
Vx-roll
Vz-yaw
9500
Wz
Wx
Wz
10
9000
9212
1400
Sz-yaw
Sx-roll
Sy-pitch
9200
D(wr)y-pitch
D(wr)z-yaw
D(wr)x-roll
9600
RCz
RCx
9510
RCz

FIG. 11

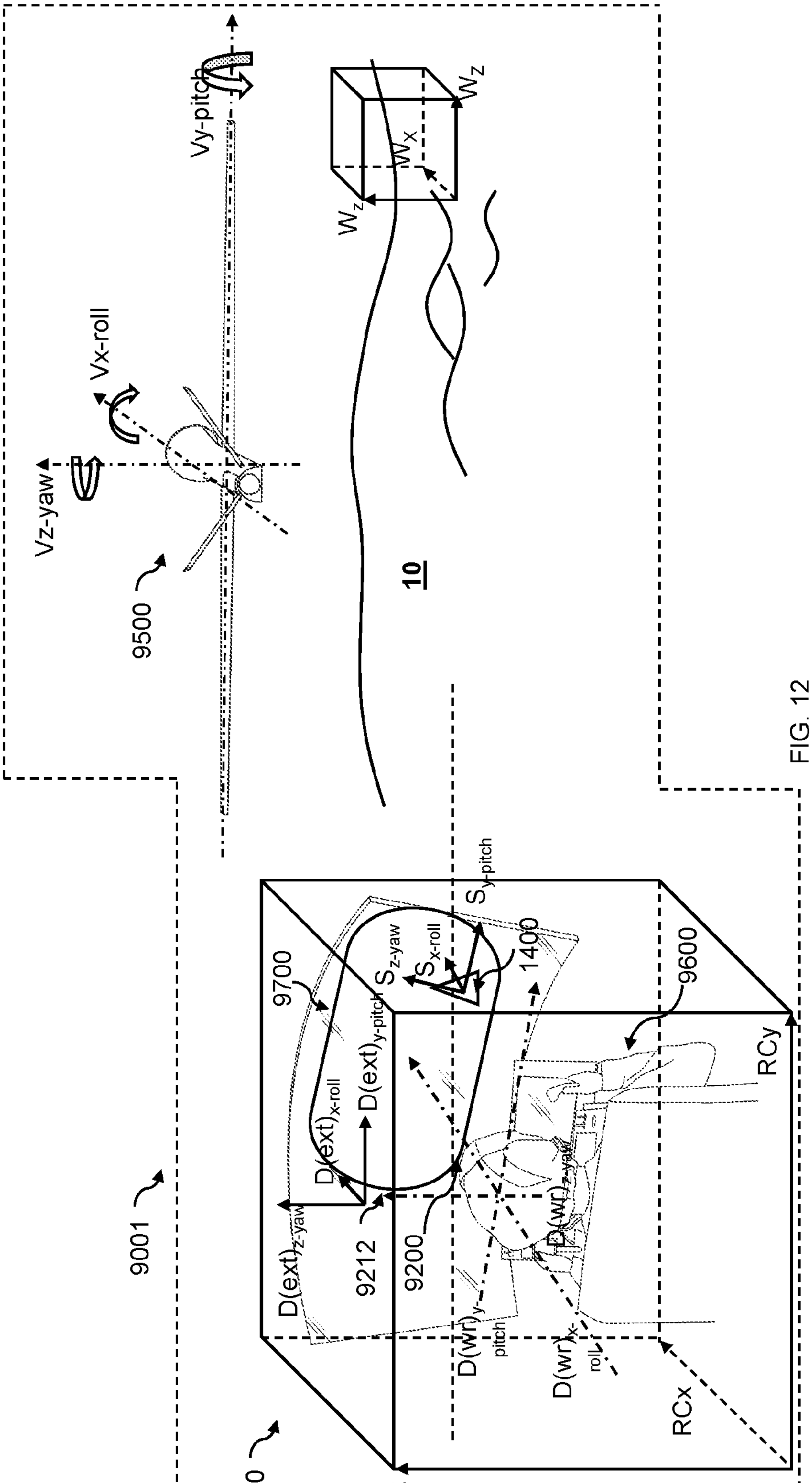
9500
Vz-yaw
Vx-roll
Vy-pitch
W_z
W_X
W_z
10
9001
9510
9700
9600
1400
$S_{y\text{-}pitch}$
$S_{z\text{-}yaw}$
$S_{x\text{-}roll}$
$D(ext)_{x\text{-}roll}$
$D(ext)_{y\text{-}pitch}$
$D(ext)_{z\text{-}yaw}$
9212
9200
$D(wr)_{y\text{-}pitch}$
$D(wr)_{x\text{-}roll}$
$D(wr)_{z\text{-}yaw}$
RCz
RCx
RCy

FIG. 12

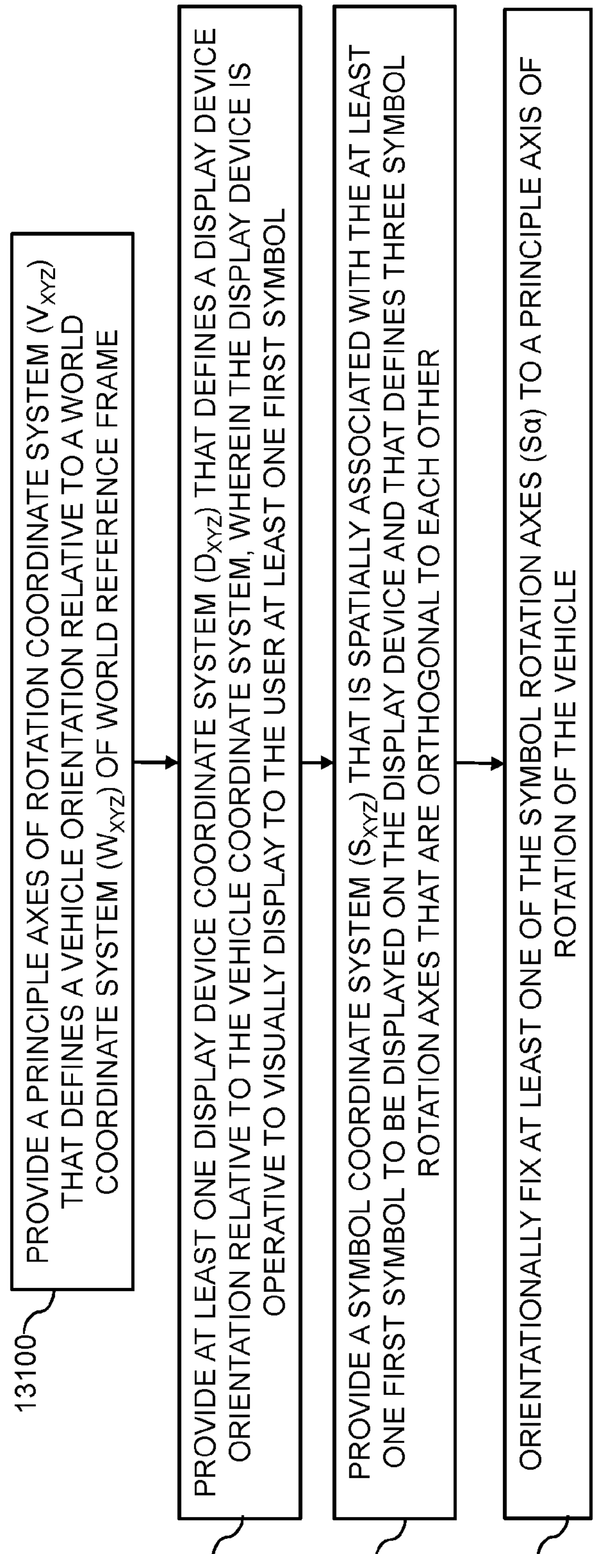
13100
PROVIDE A PRINCIPLE AXES OF ROTATION COORDINATE SYSTEM (V_{XYZ}) THAT DEFINES A VEHICLE ORIENTATION RELATIVE TO A WORLD COORDINATE SYSTEM (W_{XYZ}) OF WORLD REFERENCE FRAME
13200
PROVIDE AT LEAST ONE DISPLAY DEVICE COORDINATE SYSTEM (D_{XYZ}) THAT DEFINES A DISPLAY DEVICE ORIENTATION RELATIVE TO THE VEHICLE COORDINATE SYSTEM, WHEREIN THE DISPLAY DEVICE IS OPERATIVE TO VISUALLY DISPLAY TO THE USER AT LEAST ONE FIRST SYMBOL
13300
PROVIDE A SYMBOL COORDINATE SYSTEM (S_{XYZ}) THAT IS SPATIALLY ASSOCIATED WITH THE AT LEAST ONE FIRST SYMBOL TO BE DISPLAYED ON THE DISPLAY DEVICE AND THAT DEFINES THREE SYMBOL ROTATION AXES THAT ARE ORTHOGONAL TO EACH OTHER
13400
ORIENTATIONALLY FIX AT LEAST ONE OF THE SYMBOL ROTATION AXES (Sα) TO A PRINCIPLE AXIS OF ROTATION OF THE VEHICLE

FIG. 13

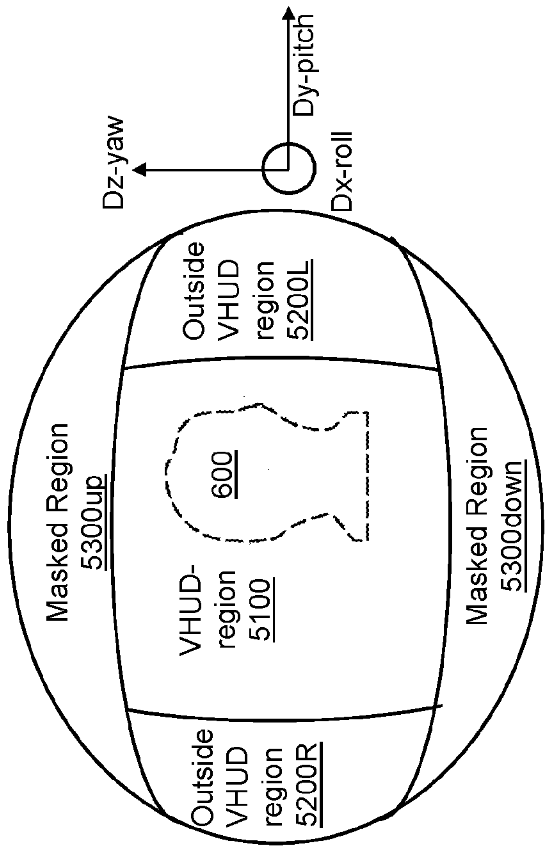

FIG. 14B

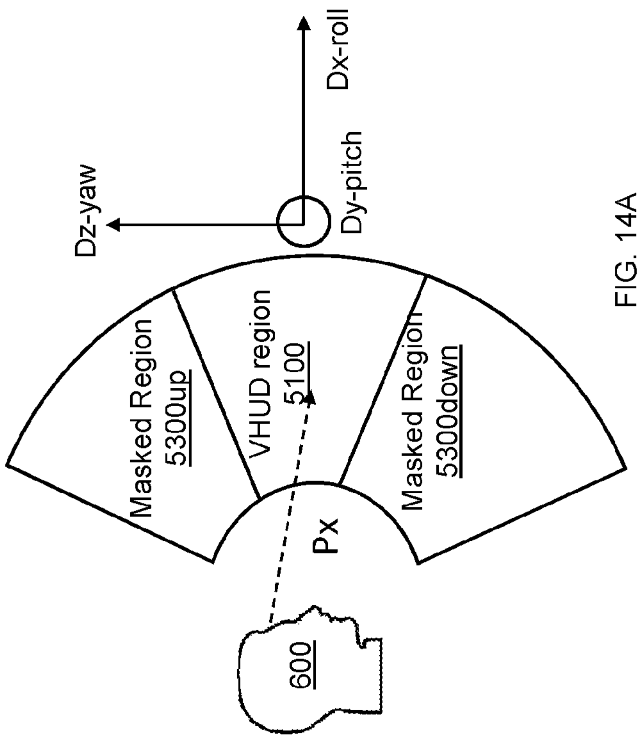

FIG. 14A

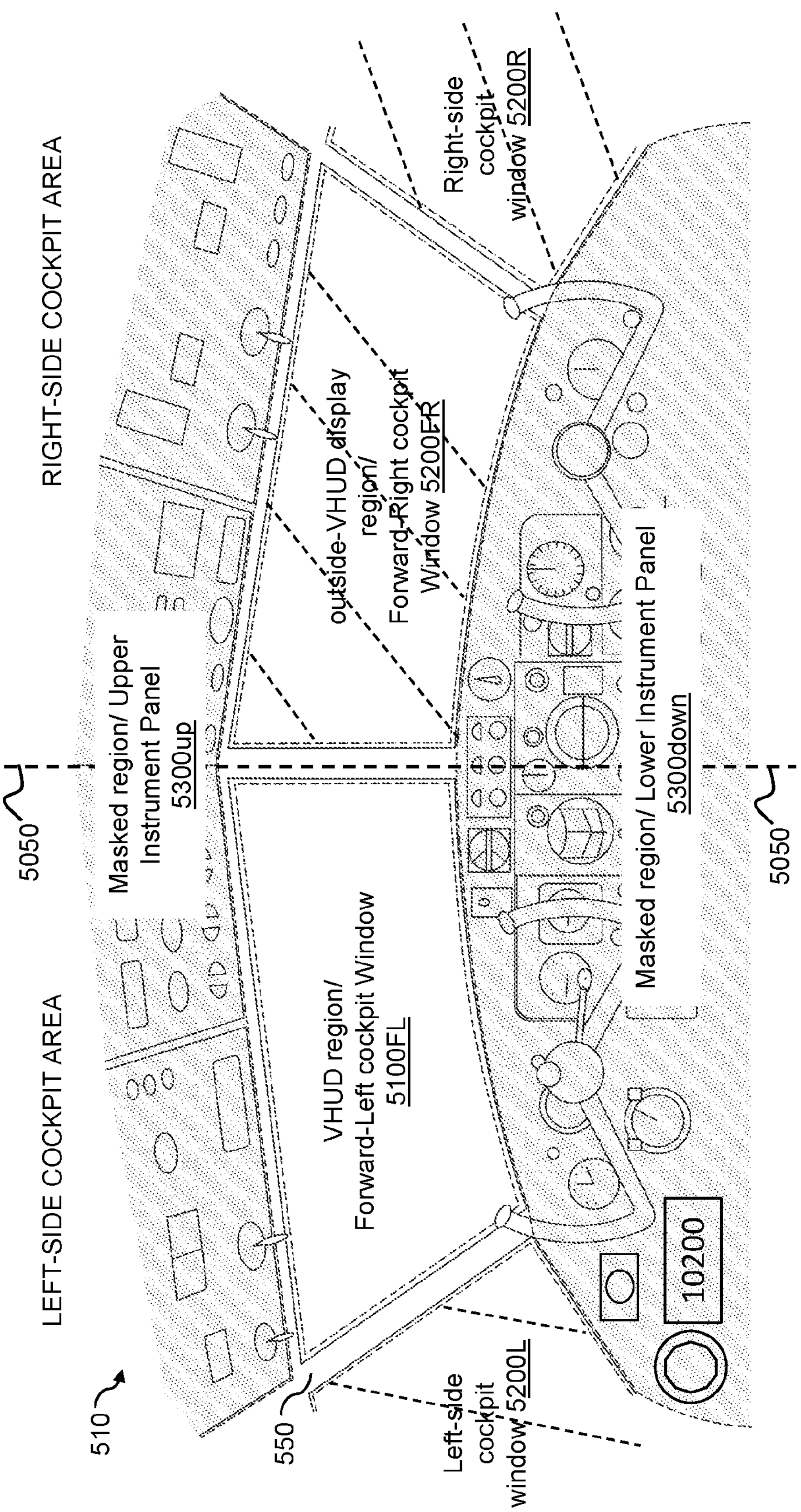
RIGHT-SIDE COCKPIT AREA
LEFT-SIDE COCKPIT AREA
Right-side cockpit window 5200R
outside-VHUD display region/ Forward-Right cockpit Window 5200FR
Masked region/ Upper Instrument Panel 5300up
5050
VHUD region/ Forward-Left cockpit Window 5100FL
Masked region/ Lower Instrument Panel 5300down
5050
10200
510
550
Left-side cockpit window 5200L

FIG. 15

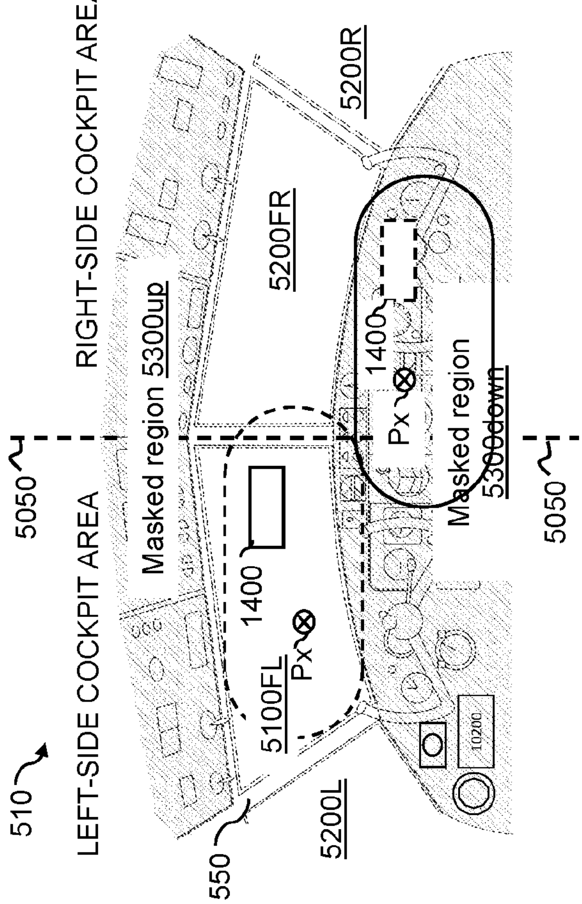

FIG. 16B

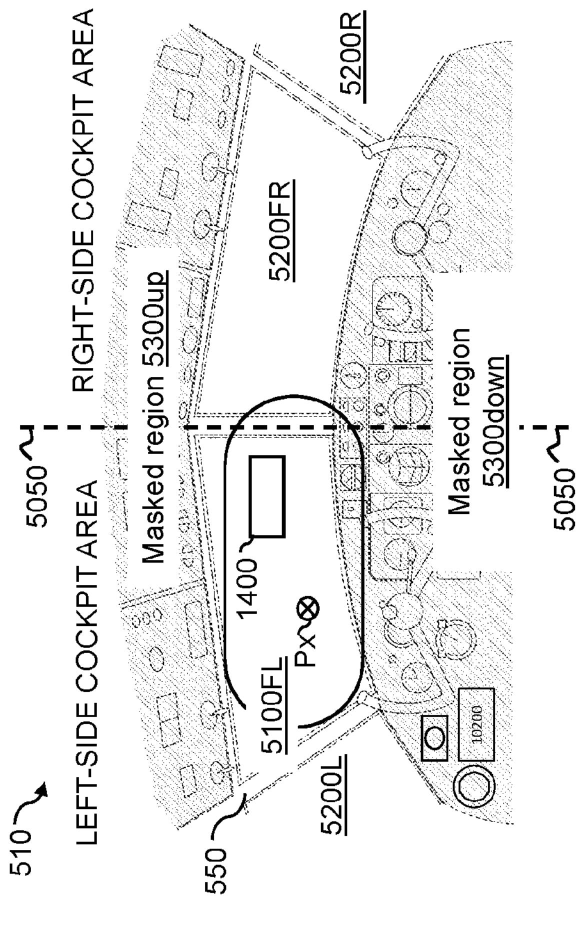

FIG. 16A

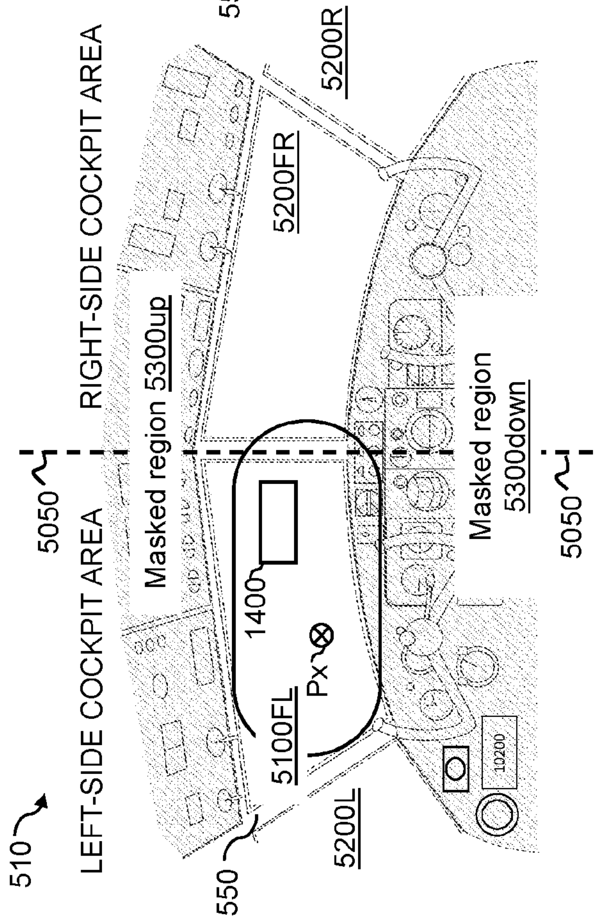

FIG. 17A

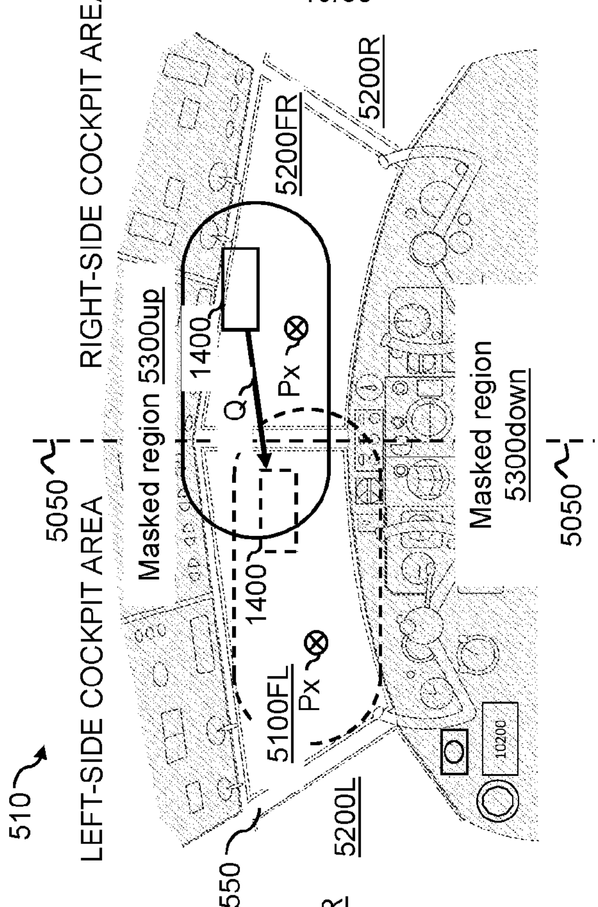

FIG. 17B

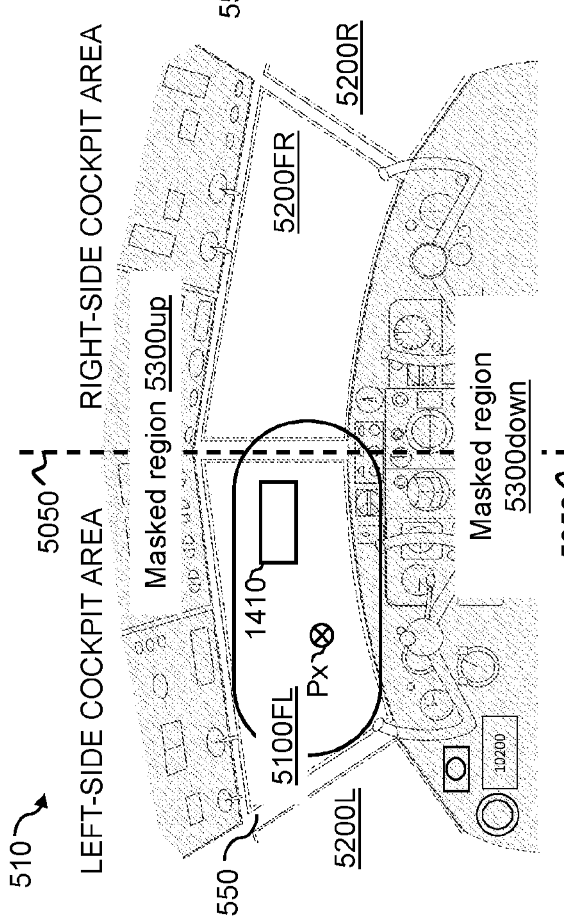

FIG. 17C

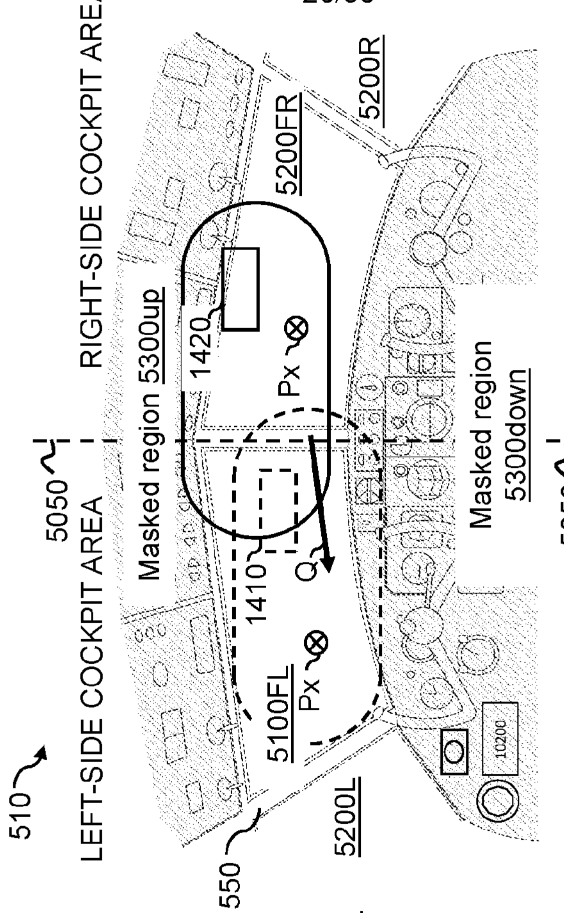

FIG. 17D

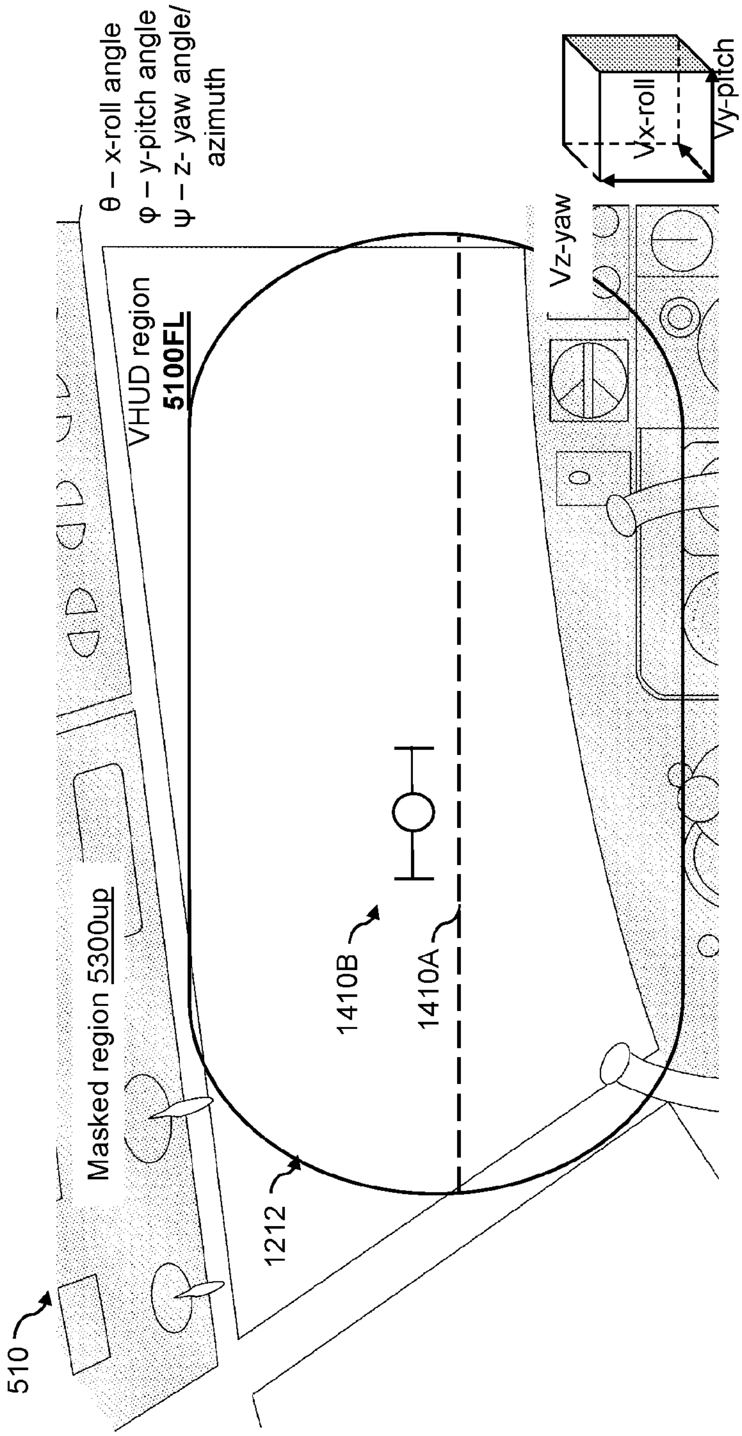
θ – x-roll angle
φ – y-pitch angle
ψ – z- yaw angle/
azimuth
Vx-roll
Vy-pitch
Vz-yaw
VHUD region
5100FL
Masked region 5300up
1410B
1410A
1212
510

FIG. 18A

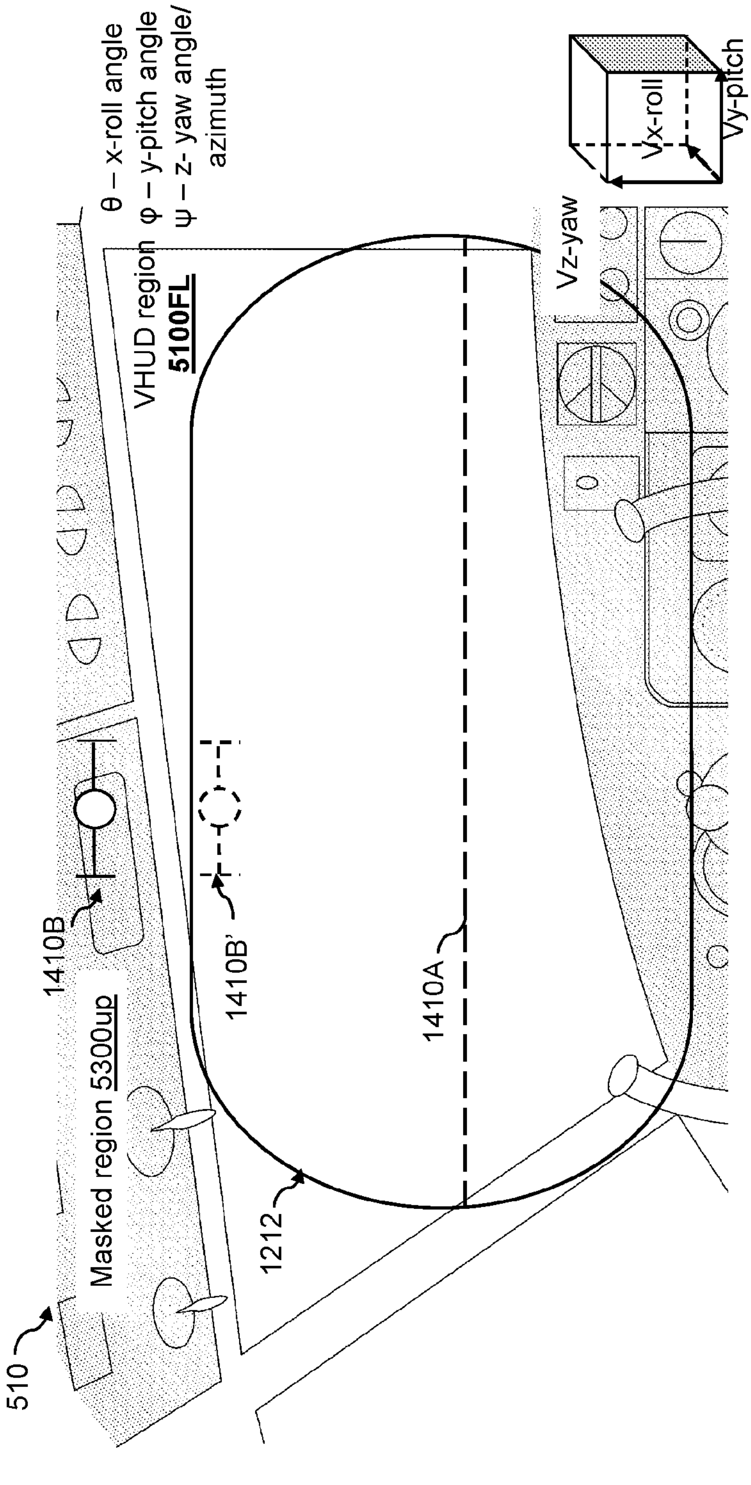
θ – x-roll angle
φ – y-pitch angle
ψ – z- yaw angle/
azimuth
VHUD region
5100FL
Vz-yaw
Vx-roll
Vy-pitch
1410B
1410B'
1410A
Masked region 5300up
1212
510

FIG. 18B

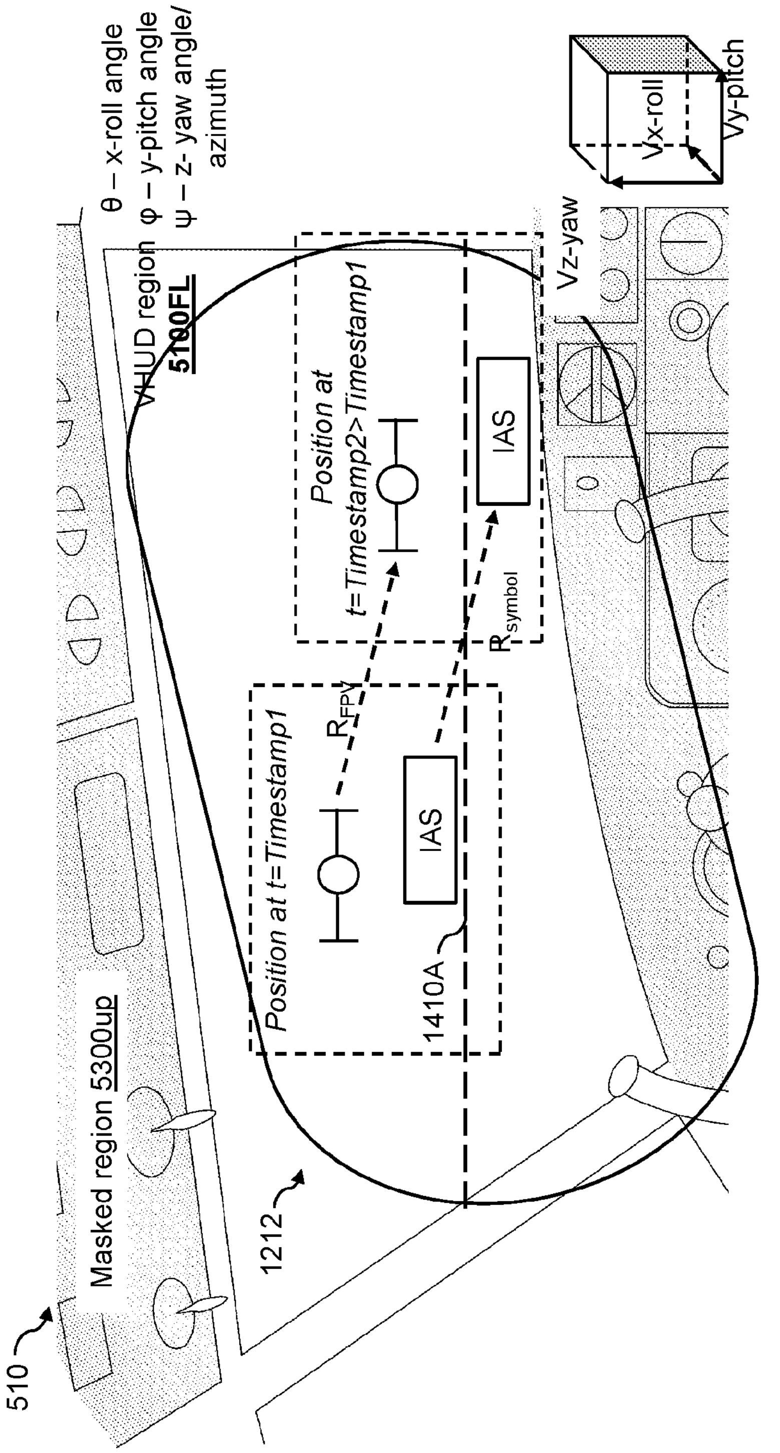
θ – x-roll angle
φ – y-pitch angle
ψ – z- yaw angle/ azimuth
VHUD region 5100FL
Position at t=Timestamp2>Timestamp1
IAS
Vz-yaw
Vx-roll
Vy-pitch
R_FPV
R_symbol
Position at t=Timestamp1
IAS
1410A
Masked region 5300up
1212
510

FIG. 18C

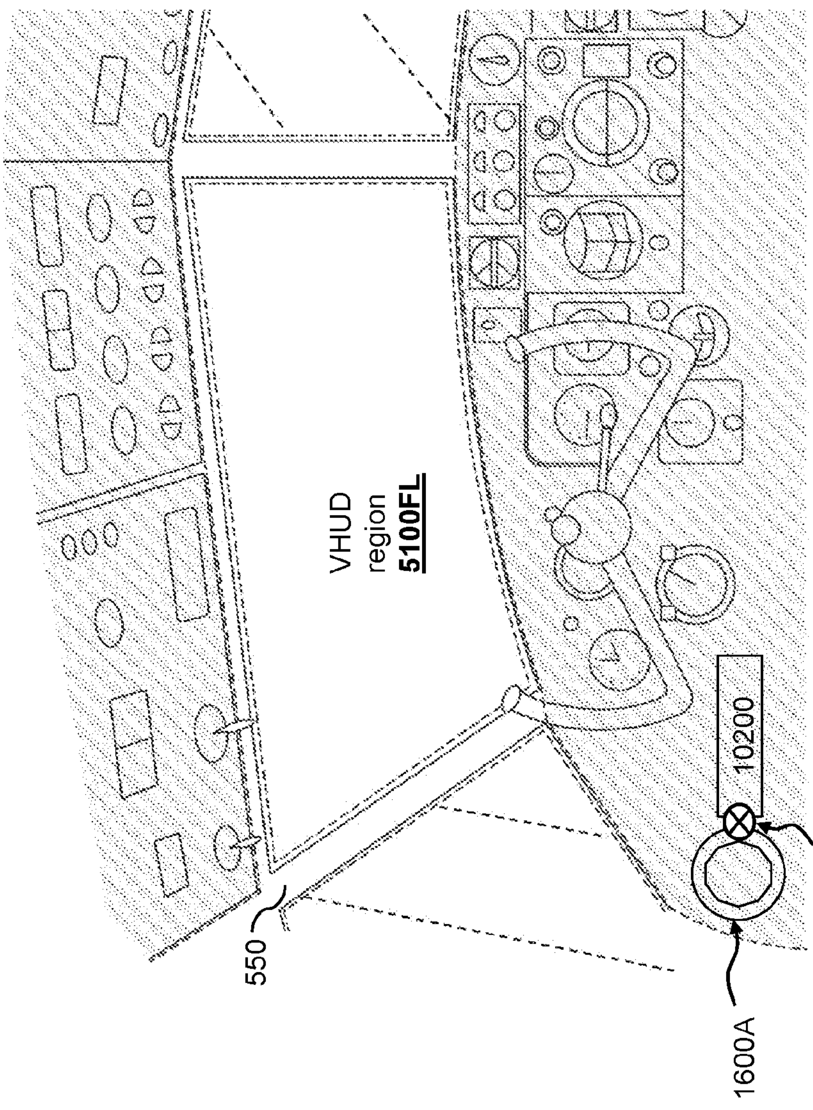

FIG. 19

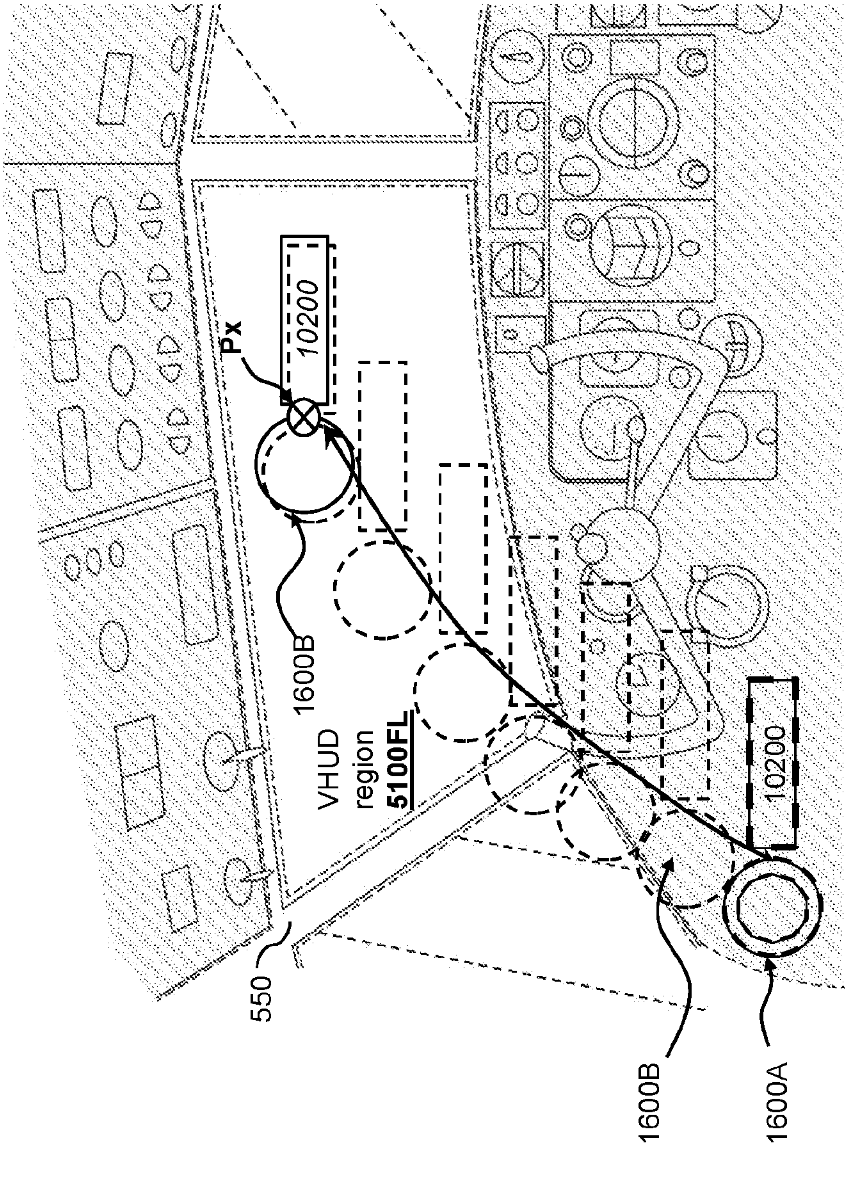

FIG. 20

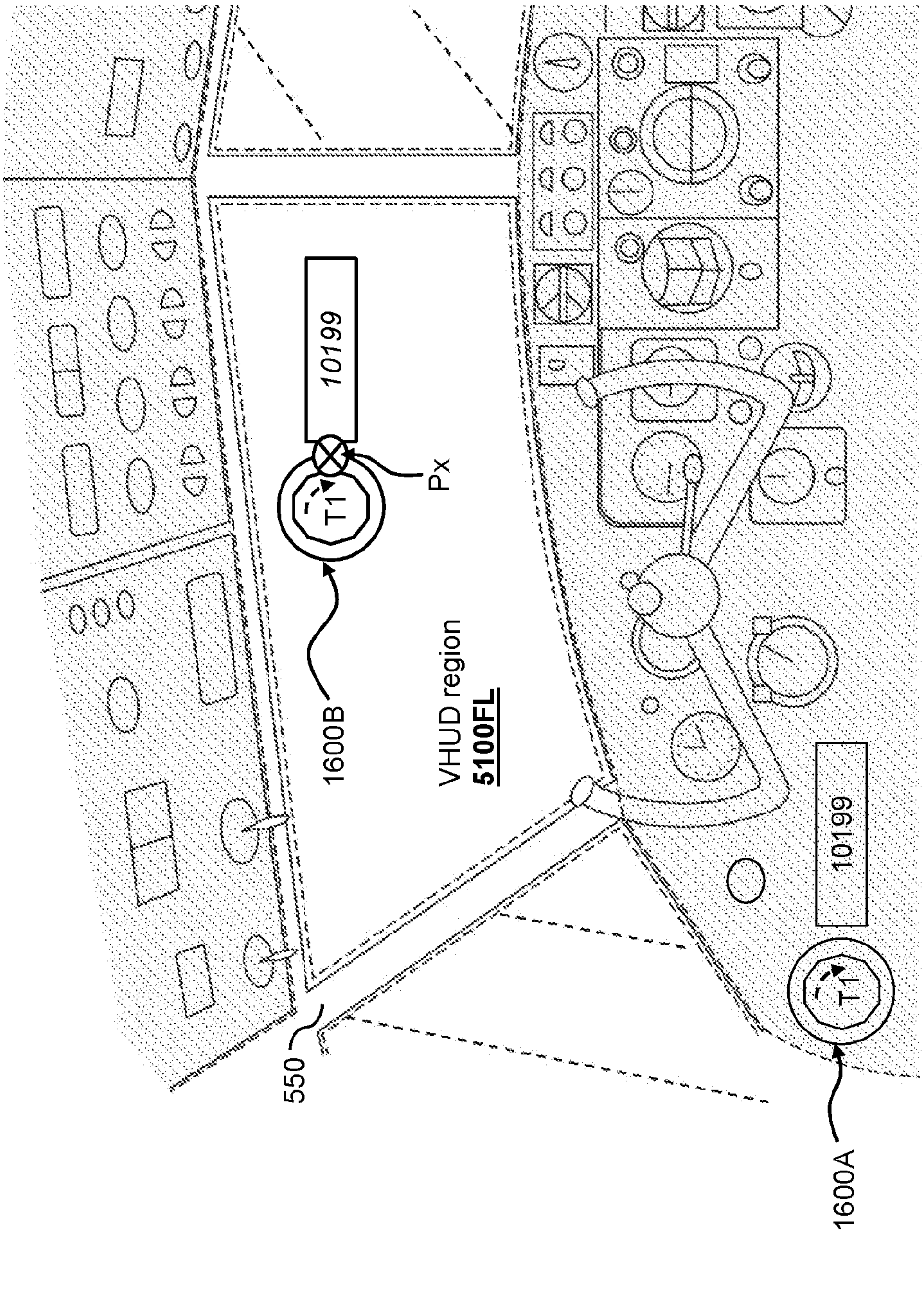

FIG. 21

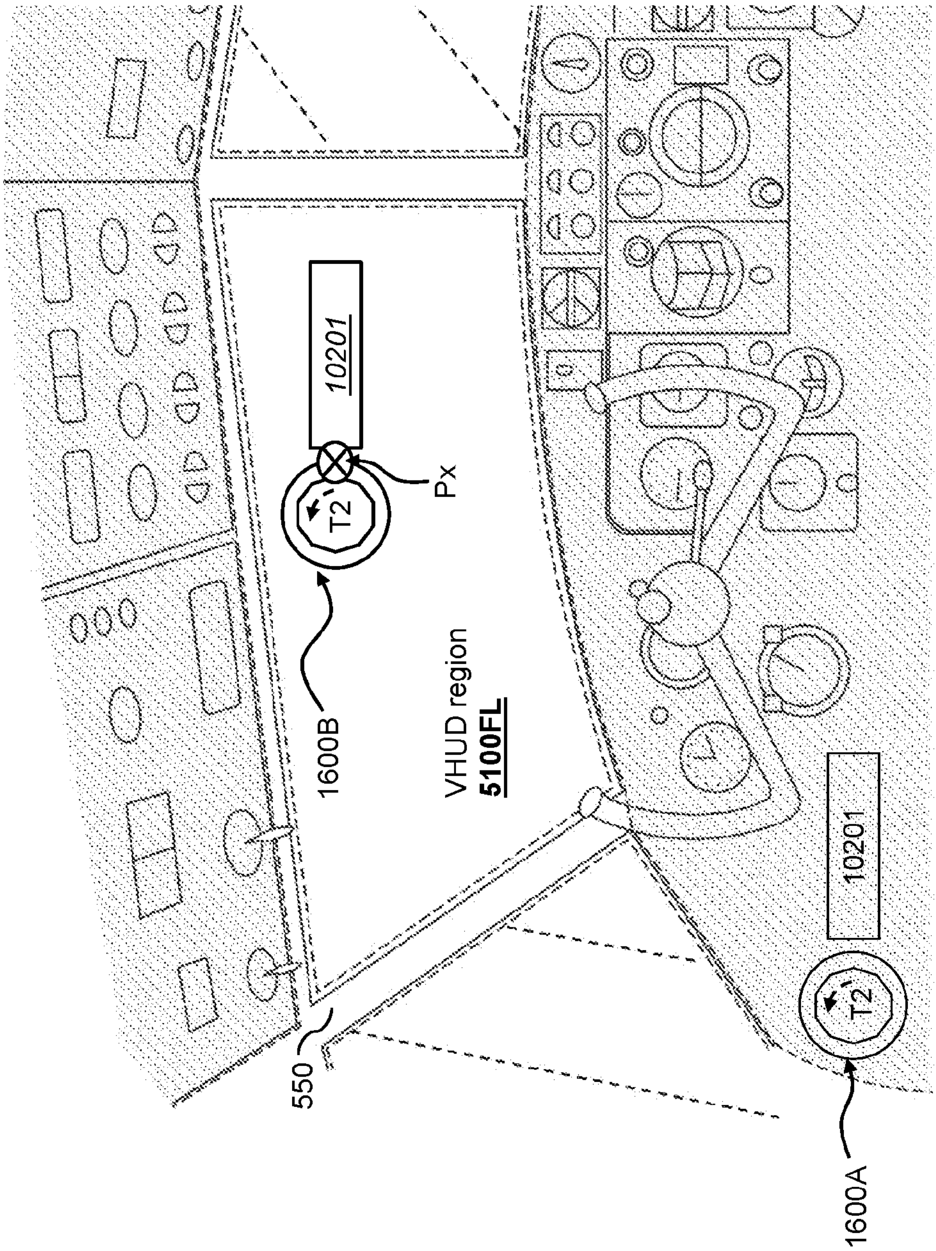

FIG. 22

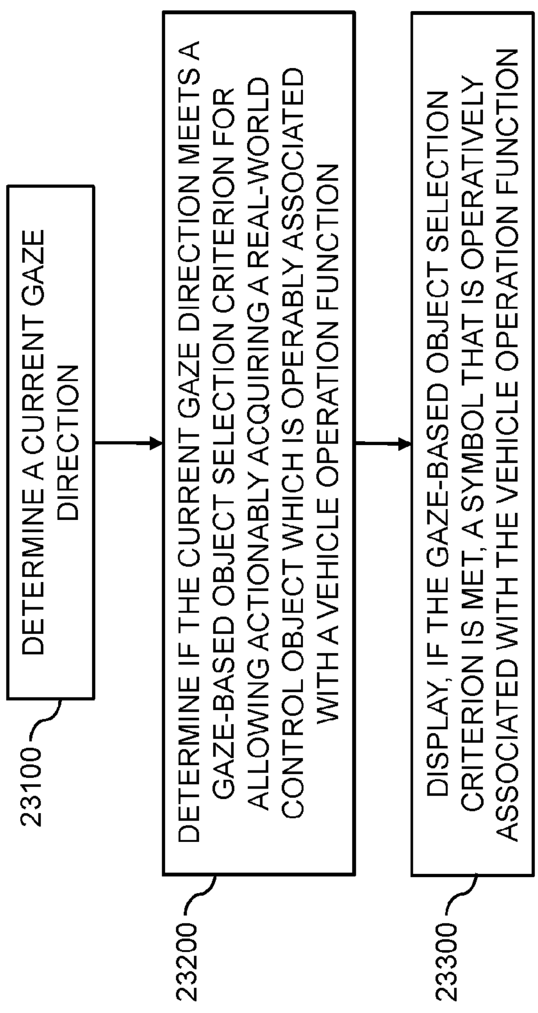
23100
DETERMINE A CURRENT GAZE DIRECTION
23200
DETERMINE IF THE CURRENT GAZE DIRECTION MEETS A GAZE-BASED OBJECT SELECTION CRITERION FOR ALLOWING ACTIONABLY ACQUIRING A REAL-WORLD CONTROL OBJECT WHICH IS OPERABLY ASSOCIATED WITH A VEHICLE OPERATION FUNCTION
23300
DISPLAY, IF THE GAZE-BASED OBJECT SELECTION CRITERION IS MET, A SYMBOL THAT IS OPERATIVELY ASSOCIATED WITH THE VEHICLE OPERATION FUNCTION

FIG. 23

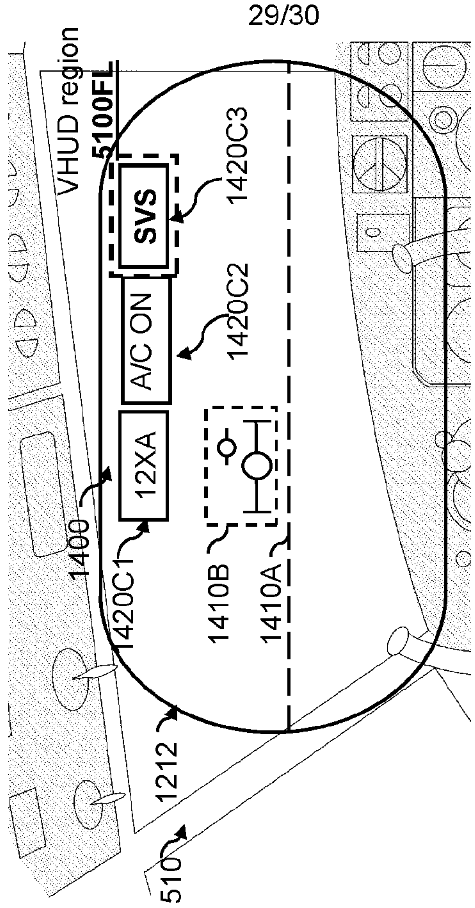

FIG. 24B

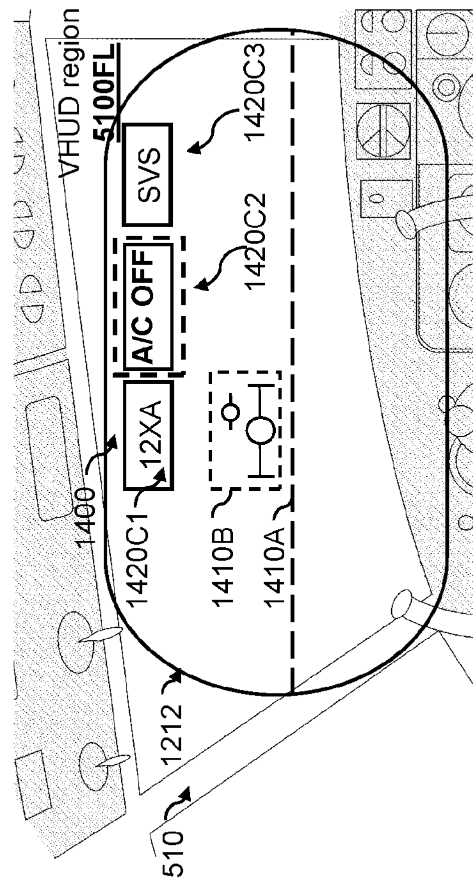

FIG. 24A

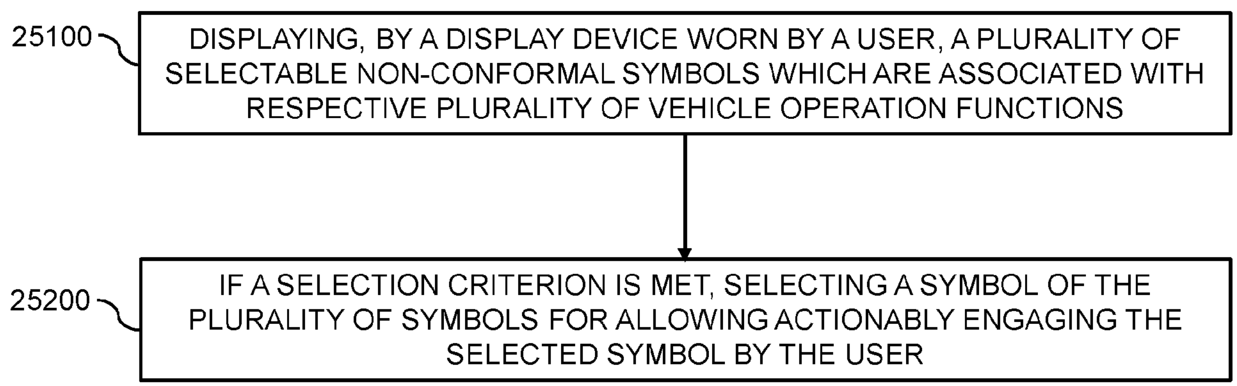
25100
DISPLAYING, BY A DISPLAY DEVICE WORN BY A USER, A PLURALITY OF SELECTABLE NON-CONFORMAL SYMBOLS WHICH ARE ASSOCIATED WITH RESPECTIVE PLURALITY OF VEHICLE OPERATION FUNCTIONS
25200
IF A SELECTION CRITERION IS MET, SELECTING A SYMBOL OF THE PLURALITY OF SYMBOLS FOR ALLOWING ACTIONABLY ENGAGING THE SELECTED SYMBOL BY THE USER

FIG. 25

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL2018/050337

A. CLASSIFICATION OF SUBJECT MATTER
IPC (2018.01) G02B 27/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC (2018.01) G02B 27/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Databases consulted: Orbit

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2011282130 A1 KRUEGER WESLEY WO; ADVITECH INC 17 Nov 2011 (2011/11/17) The whole document	1-48
A	US 2014097291 A1 THALES SA 10 Apr 2014 (2014/04/10) The whole document	1-48
A	US 2012293395 A1 WILLIAMS JOHN RICHARD; BAE SYSTEMS PLC 22 Nov 2012 (2012/11/22) The whole document	1-48

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 Jun 2018	02 Jul 2018

Name and mailing address of the ISA:	Authorized officer
Israel Patent Office Technology Park, Bldg.5, Malcha, Jerusalem, 9695101, Israel Facsimile No. 972-2-5651616	BITTON Oren Telephone No. 972-2-5657812

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IL2018/050337

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
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		US 8690750 B2	08 Apr 2014
		US 2014152792 A1	05 Jun 2014
		US 9298985 B2	29 Mar 2016
		US 2016167672 A1	16 Jun 2016
		US 9994228 B2	12 Jun 2018
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		US 9422051 B2	23 Aug 2016
		EP 2703928 A1	05 Mar 2014
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		FR 2995092 B1	13 Nov 2015
US 2012293395 A1	22 Nov 2012	US 2012293395 A1	22 Nov 2012
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		EP 2513701 A1	24 Oct 2012
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		GB 0922022 D0	03 Feb 2010
		WO 2011073682 A1	23 Jun 2011