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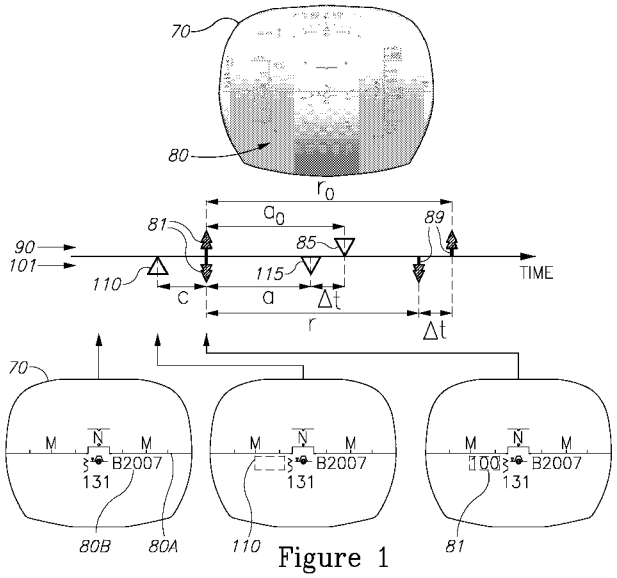

Figure 1

(57) Abstract: Systems and methods are provided, for managing the attention of a user attending a display and for managing displayed information in control centers. Methods and systems may identify, from displayed data, a piece of information, locate a display position of the identified piece of information, and display the visual cue at a specified interval prior to displaying the piece of information, at a cue position on the display that has a specified spatial relation to the display position of the piece of information. Methods and systems may further quantify an attention pattern of a user, relate it to recorded reaction times of the user to the displayed data, and modify spatio-temporal parameters of the visual cues to decrease the user's reaction times according to specified requirements. Specific data may be enhanced according to user performance and various definitions.

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ADJUSTING DISPLAYS ON USER MONITORS AND GUIDING USERS' ATTENTION

BACKGROUND OF THE INVENTION

1. TECHNICAL FIELD

[0001] The present invention relates to the field of user-display interaction, and more particularly, to guiding user attention during the use of the display.

2. DISCUSSION OF RELATED ART

[0002] Displays of aircrafts and of vehicles , as well as station displays of various control centers (e.g., air control centers, unmanned aircraft control centers, traffic control centers, lookout control systems, border controls, rescue systems etc.) commonly include a large amount of data. The clutter of these displays presents a significant challenge to users such as drivers or pilots.

[0003] Posner et al. 1980 (J. of Experimental Psychology: General, vol. 109, 2, pp: 160-174), which is incorporated herein by reference in its entirety, discusses the relation of attention to the detection of signals and shows that detection latencies are reduced when subjects receive a cue that indicates where in the visual field the signal will occur.

[0004] Weiquan, Lu 2013 (National university of Singapore, Thesis), which is incorporated herein by reference in its entirety, teaches improving visual search performance in augmented reality environments using a subtle cueing approach, and compares explicit cueing with subtle cueing as ways to draw attention of an observer.

SUMMARY OF THE INVENTION

[0005] The following is a simplified summary providing an initial understanding of the invention. The summary does not necessarily identify key elements nor limits the scope of the invention, but merely serves as an introduction to the following description.

[0006] One aspect of the present invention provides a method comprising identifying, from display-relevant data, a piece of information, locating, on a respective display, a display position of the identified piece of information, and displaying the visual cue at a specified interval prior to displaying the piece of information, at a cue position on the display that has a specified spatial relation to the display position of the piece of information.

[0007] These, additional, and/or other aspects and/or advantages of the present invention are set forth in the detailed description which follows; possibly inferable from the detailed description; and/or learnable by practice of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] For a better understanding of embodiments of the invention and to show how the same may be carried into effect, reference will now be made, purely by way of example, to the accompanying drawings in which like numerals designate corresponding elements or sections throughout.

[0009] In the accompanying drawings:

[0010] **Figures 1** and **2** are high level schematic illustrations of a cueing paradigm, according to some embodiments of the invention.

[0011] **Figure 3** is a high level schematic block diagram of a cueing system, according to some embodiments of the invention.

[0012] **Figure 4A** and **4B** examples of clutter in control center displays, according to some embodiments of the invention.

[0013] **Figure 5** is a high level schematic block diagram of a system for improving information flow through control centers, according to some embodiments of the invention.

[0014] **Figure 6** is a high level schematic illustration of selection of displayed information, according to some embodiments of the invention.

[0015] **Figure 7** is a high level schematic flowchart illustrating a method, according to some embodiments of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0016] Prior to the detailed description being set forth, it may be helpful to set forth definitions of certain terms that will be used hereinafter.

[0017] The term “display” as used in this application refers to any device for at least partly visual representation of data to a user.

[0018] The term “display-relevant data” as used in this application refers to the overall assembly of data elements which may be presented on a display, including various data types, various data values, various alerts etc.

[0019] The term "piece of information" as used in this application refers to specific data items, data points or alerts, prior to their presentation on the display.

[0020] The term "display position" as used in this application refers to a designated location on the display in which the piece of information is to be displayed. No data or any data may be displayed at the display position prior to the display of the piece of information, including a similar piece of information.

[0021] The term "stimulus" as used in this application refers to an actual display of the piece of information.

[0022] The term "cue" as used in this application refers to a graphical element that does not convey the information content of the stimulus, but relates geometrically to the display position of the stimulus.

[0023] The term "cue position" as used in this application refers to a location of the displayed cue on the display or at its margins.

[0024] With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

[0025] Before at least one embodiment of the invention is explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is applicable to other embodiments that may be practiced or carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein is for the purpose of description and should not be regarded as limiting.

[0026] Systems and methods are provided, for managing the attention of a user attending a display and for managing displayed information in control centers. Methods and systems may identify, from displayed data, a piece of information, locate a display position of the identified piece of information, and display the visual cue at a specified interval prior to displaying the piece of information, at a cue position on the display that has a specified spatial relation to the

display position of the piece of information. Methods and systems may further quantify an attention pattern of a user, relate it to recorded reaction times of the user to the displayed data, and modify spatio-temporal parameters of the visual cues to decrease the user's reaction times according to specified requirements. The recorded information, associated with identified users, may be used as a baseline for future user-system interaction. Methods and systems may select relevant data from display-relevant data, the relevance thereof determined according to user definitions, mode definitions and/or mission definitions, display the relevant data and monitor user reactions thereto, and enhance specific data from the relevant data according to the monitored user reactions with respect to the user definitions, mode definitions and/or mission definitions. Cueing patterns may be personalized and adjusted to information priorities and user performance.

[0027] **Figures 1** and **2** are high level schematic illustrations of a cueing paradigm **101**, according to some embodiments of the invention. The top of **Figure 1** exemplifies current aircraft displays **70** with a large amount of display-relevant data **80**. The middle of **Figure 1** schematically illustrate a time line with prior art stimulation paradigm **90** including a stimulus **81** (e.g., display or modification of an information piece or a data item of display-relevant data **80**), an attendance **85** of a display user to stimulus **81** (manifested e.g., in a correlated eye movement) and a resulting action **89** of the user. The time between stimulus presentation **81** and attendance **85** is denoted by a_0 (time to attention reorientation) and the overall time between stimulus presentation **81** and resulting action **89** (the reaction time) is denoted by r_0. It is noted that displays **70** may comprise any of head up displays (HUD), head mounted displays (HMD), down displays, near-to-eye (NTE) display, any type of display such as CRT (cathode ray tube), LCD (liquid crystal display), LED (light emitting diodes display) etc. as well as virtual displays such as augmented reality visors.

[0028] The timeline also presents a cueing paradigm **101** that comprises, according to some embodiments, presentation of a cue **110** to attract the user's attention prior to presentation of stimulus **81**. For example, cue **110** may be presented at time c (e.g., 1ms<c<**300**ms) prior to stimulus **81**. As a result, the user attends **115** stimulus **81** earlier than the user attends **85** stimulus **81** without cue **110**, namely after a shorter period $a<a_0$. As a result, using cueing paradigm **101**, the user's reaction time shortens from r_0 to r (measured from stimulus **81** to action **89**), by Δt. The lower part of **Figure 1** demonstrates in a non-limiting manner simplified HUD **70** with constant data **80A** (e.g., a horizon) and dynamic data **80B** (e.g., an altitude, a velocity, an angle),

and the presentation of visual cue **110** (e.g., a rectangle enclosing the position of the stimulus) prior to the presentation of stimulus **81** according to the timeline. It is noted that the cue precedence time *c*, i.e., the time in which cue **110** is visible before the appearance of the actual information (stimulus **81**) may vary, e.g., between 10-500ms, depending on various circumstances, such as the importance of the information, other data appearing in the region, prior cues and stimuli etc. It is further noted that a duration of cue **110** may be short or long (e.g., between 50ms-1500ms), and cue **110** may at least partially overlap stimulus **81** (denoted by the broken line). Cue duration may likewise depend on various circumstances, such as the importance of the information, other data appearing in the region, prior cues and stimuli etc. Cues **110** may comprise graphical elements such as frames that enclose stimulus **81**, arrows pointing to the location of stimulus **81**, flankers displayed at the edge of the display beyond the position of stimulus **81** but at the angle of stimulus **81** and any other graphical element which may attract the user's attention to stimulus **81**.

[0029] It is noted that different cues and cue parameters may be associated with different types of data and with different information contents of the data. For example, certain cue shapes and/or colors may be associated with different data type, cues may be made more prominent on the display as the information they attract the user's attention to is more important, and so forth.

[0030] **Figure 2** illustrates schematically a timeline for multiple stimuli **81A**, **81B**, and resulting actions **89A**, **89B** according to prior art paradigm **90** (above timeline) and according to cueing paradigm **101**. Cueing, using visual cues **110A**, **110B**, yield earlier attendance times **115A**, **115B** than prior art attendance times **85A**, **85B**, which may result in a cumulative shortening of the overall reaction time, Σr (in cueing paradigm **101**) < Σr_0 (in prior art paradigm **90**), in case consecutive stimuli **81B** are presented earlier in cueing paradigm **101** than in prior art paradigm **90** due to the shortened response time of the user. For example, in the illustrated case, the reaction time to first stimulus **81A** is shortened by Δt_1, and consecutive stimulus **81B** is presented Δt_2 earlier than in the prior art, resulting in shortening the overall reaction time by $\Delta t_1+\Delta t_2$, allowing more information to be presented to the user within a given time period. It is noted that intervals c_1, c_2 of presenting cues **110A**, **110B** before stimuli **81A**, **81B**, respectively, may be modified and adapted to an overall stimuli presentation scheme.

[0031] **Figure 3** is a high level schematic block diagram of a cueing system **100**, according to some embodiments of the invention. System **100** comprises a cueing module **120** in communication with a display module **105** that operates a display **70**. Cueing module **120** may be

configured to identify, from display-relevant data **80**, a piece of information (e.g., by an information selector **122**), locate a display position of the identified piece of information, and instruct display module **105** to display visual cue **110** at a specified interval (e.g., between 10 and 500ms) prior to displaying the piece of information, at a cue position on display **70** that has a specified spatial relation to the display position of the piece of information (e.g., at the same location or within an angular range corresponding to fovea size). System **100** may further comprise display module **105** and/or display **70** and implement any of cueing paradigms **101** described above. In certain embodiments, visual cue **110** may be selected (e.g., by a cue selector **124**) according to visual parameters of display-relevant data **80** such as position on the display, font and size, color, etc. Visual cue **110** may be similar in one or more visual parameter to stimulus **81**, may vary in one or more visual parameter to stimulus **81** and/or the level of similarity between Visual cue **110** and stimulus **81** may be adjusted according to various parameters, such as importance or urgency of stimulus **81**, detected tendencies of the user to miss stimulus **81** (based on past experience), other currently displayed data etc.

[0032] Display-relevant data **80** may comprise constant data **80A** and dynamic data **80B**. Visual cues **110** mainly refer to the latter. Cueing module **120** may be configured to present a plurality of visual cues **110** according to a specified display scanning scheme, e.g., a typical pilot display scanning scheme.

[0033] In certain embodiments, cueing module **120** may be further configured to configure visual cues **110** according to urgency parameters of the piece of information.

[0034] Cueing module **120** may be configured to maintain a specified period between repetitions of visual cues **110** at a specified range of cue positions, to reduce the inhibition of return (IOR) phenomenon of slower reaction to cue repetitions at a same location. For example, within a certain predefined angular range (e.g., corresponding to one or several fovea sizes), repetitions of visual cues **110** may be limited to less than one per 1sec. It is noted that IOR is typically about 200ms, but may vary between users and vary significantly depending on different circumstances such as the region of the display, the user occupancy and general attention, and other factors. System **100** (e.g., via feedback module **130** and/or via training module **140,** as explained below) may be configured to measure the user's IOR or evaluate the user's cue awareness in other ways, and adjust the cueing scheme accordingly. For example, cue durations, intervals between cues and cued stimuli may be adjusted accordingly.

[0035] In certain embodiments, system **100** may comprise a feedback module **130** in communication with cueing module **120** and with a monitoring module **60** that monitors a user of display **70**. For example, monitoring module **60** may comprise a user attention tracker **65** (e.g., an eye tracker) configured to follow the tempo-spatial shifts of attention of the user, and/or a user reaction monitor **69** configured to follow user actions **89** with respect to stimuli **81**. In certain embodiments, monitoring module **60** may comprise or employ any sensor or method to track users' attention and reactions. In one example, an inertial measurement unit (IMU) in a HMD may be used to monitor the user head movements to verify specified scanning patterns or the efficiency of specific attention drawing cues. In another example, monitoring module **60** may check for expected responses of the user (e.g., an audio commend that should result from a specific displayed piece of information) and report expected reactions or lack thereof.

[0036] Feedback module **130** may be configured to evaluate an efficiency of the cueing, and cueing module **120** may be further configured to modify one or more parameter of visual cues **110** according to the evaluated efficiency. For example, any parameter of visual cues **110** such as its timing (e.g., the specified period *c* before stimulus **81**, the duration of cue **110**, inter-cue periods etc.), its graphical features such as color, shape and size with respect to surroundings in display **70**, the relative position of cue **110** with respect to stimulus **81**, etc.

[0037] In certain embodiments, system **100** may comprise a training module **140** in communication with cueing module **120** and with monitoring module **60**. Monitoring module **60** may be configured to identify a display scanning scheme of a user of display **70**, and training module **140** may be configured to present multiple visual cues **110** to correct the user's display scanning scheme with respect to a specified required display scanning scheme. Training module **140** may be configured to provide any number of benefits, such as streamlining the user's use of the display, reducing the user's reaction times, improve reaction times to certain types of data or to unexpected data and generally improve the situational awareness of the user. Training module **140** may be personalized, with different settings for differently trained users, determined ahead of training and/or based on prior training data.

[0038] In certain embodiments, system **100** may comprise a quantifying module **150** configured to quantify an attention pattern **155** of a user with respect to the displayed data and visual cues. Attention pattern **155** may comprise a spatio-temporal relation of estimated locations of a user's attention to the displayed data and visual cues, as measured e.g., by attention tracker **65** such as an eye tracker or as received by the vehicle's host-system (that operates the display). Quantifying

module **150** may be further configured to relate quantified attention pattern **155** to a user's reaction pattern **159** that includes recorded reaction times of the user to the displayed data (as measured e.g., by user reaction monitor **69,** in form of the user's reaction to the cued information). The relations between attention pattern **155** and reaction pattern **159** may be used in various ways, for example by feedback module **130** to evaluate the effectiveness of different cues with respect to the user's reaction times, and/or by training module **140** that may be further configured to modify spatio-temporal parameters of the visual cues to decrease the user's reaction times according to specified requirements.

[0039] Any element of system **100**, in particular feedback module **130** and/or training module **140**, may be configured to process user specific data. For example, system **100** may comprise a user identification module (not shown) for processing data and adjusting cueing patterns to a user's past reaction database. The identification of the user may be carried out by any type of user input (e.g., by code or user name) or by automatic user identification according to the user's physiological parameters (e.g., weight on seat, eye scan etc.) as well as according to user reaction to displayed information, stimuli and cues (e.g., according to display scanning pattern). Feedback module **130** and/or training module **140** may be configured to associate specific cueing patterns and user reactions to specified users, and possibly also to identify users according to their display interaction patterns. In certain embodiments, feedback module **130** and/or training module **140** may be configured to provide user related cueing information for later analysis or to save user reaction patterns and times for future usage. In certain embodiments, user identification and/or user-related analysis capabilities may be at least partly incorporated into monitoring module **60**.

[0040] System **100** may be configured to guide the user's attention to specific positions of the display and/or to specific events that require user response, e.g., according to predefined rules. System **100** may be configured to implement different cueing schemes. For example, different users may be prompted by different cueing schemes depending on their habits, scanning patterns and/or depending on the displayed information content. The cueing schemes may be adapted as user attentiveness changes, e.g., due to habituation, fatigue and/or training. Feedback module **130** may be configured to provide data required for adapting the cueing scheme. System **100** may further comprise a managing module **160** configured to manage cueing schemes for different users and with respect to data from feedback and training modules **130**, **140**. Alternatively or complementarily, managing module **160** may be configured to control the displayed data according to feedback data, e.g., increase or reduce the levels of cluster on the display and/or

managing module **160** may be configured to control the monitoring of the user to monitor specific reactions of the user.

[0041] In certain embodiments, system **100** may be further configured to change data display parameters, update information and change displayed information with or without respect to the implemented cueing. For example, clutter may be reduced by attenuating less important data (e.g., by dimming the respective displayed data) or enhance more important data (e.g., by changing the size, brightness or color of respective displayed data or pieces of information), possibly according to specified criteria which relate to user identity, current situation, operational mode etc. Examples for operational modes, in the non-limiting context of a pilot, are various parts of flight and aircraft control patterns such as taking off, climbing, cruising, approaching an air field, descending, landing, movements on the ground, taxiing, etc. In each mode, different flight information is relevant – e.g., during takeoff only momentary velocity and height and general navigation aids are displayed, during approaches exact navigation aids are displayed, during landing on the runaway velocity and runaway-related data (e.g., available distance, expected stopping point), during taxiing atmospheric and navigation information may be presented and so forth. Operational modes may also comprise situation-related or mission-related modes, for example, malfunctions may be defined as operational modes that require displaying certain parameters, flight parameters may change between area reconnaissance and other flight missions as well as among various flight profiles (e.g., high and low altitudes, profiles related to different mission stages etc.).

[0042] In certain embodiments, stimuli **81** may be used as corresponding cues **110** and displayed prior to scheduled display timing of stimuli **81** or with same or different parameters than regularly presented.

[0043] In certain embodiments, system **100** may be configured to use audio cues **110** or alerts that relate to stimuli **81**, in place or in addition to visual cues **110**. In certain embodiments. The spatial apparent location of audio cues **110** may be related to the spatial location of corresponding stimulus **81** and/or to a type of information presented as stimulus **81**, its priority, its importance according to specified criteria, etc.

[0044] In certain embodiments, system **100** may be integrated in control center software to enhance the usability of control center displays by users. System **100** may be configured to be applicable to any control station and to any display.

[0045] **Figure 4A** and **4B** examples of clutter **80** in control center displays **70**, according to some embodiments of the invention. **Figure 4A** illustrates an area control center (ACC) depiction of air traffic during the September 11 attacks. Highlighted information **81** is identified as stimuli **81** that might have been enhanced over clutter **80** and might have contributed to the crisis prevention or management if users of displays **70** were made aware of it. **Figure 4B** illustrates an ACC depiction of air traffic over the ocean. Clutter **80** in display **70** is characterized by many aircrafts, each associate with multiple displayed data items. Keeping an overview of such clutter **80** is very difficult, and system **100** may be used to highlight specific data which is determined by system **100** as being specifically relevant to a specific user at a specific control station (display **70**) and/or at a specific situation or task. Alternatively or complementarily, system **100** may be configured to cue certain pieces of information to shorten the reaction time of the respective user thereto.

[0046] **Figure 5** is a high level schematic block diagram of system **100** for improving information flow through control centers, according to some embodiments of the invention. It is noted that the control centers may be of any kind, such as air control centers, unmanned aircraft control centers, traffic control centers, lookout control systems, border controls, rescue systems etc. In particular, system **100** may be implemented for managing displays of any station that provide users with multi-layered information may be displayed according to various types of users, various priorities, various operational context and any other criteria. Managing module **160** may be configured to receive user and unit definitions **162** (e.g., user priorities, ranks, permissions etc.), mode definitions **164** and/or operational definitions **166** (e.g., relating to specified missions) and adjust displayed information **80** on displays **70** accordingly. As exemplified above, managing module **160** may enhance or attenuate certain data items, determine configurations of displayed data, integrate data from different sources for presentation, monitor cueing schemes and their effect on user performance and event handling, monitor user reactions to displayed data (e.g., receiving data from user monitoring modules **60** and/or feedback and training modules **130**, **140**) and modify displaying parameters according to defined priorities and with respect to ongoing events. System **100** may be configured to adapt the displayed information according to user priorities, ranks, permissions etc. System **100** may be configured to test user alertness by monitoring specific pieces of information and monitoring user reactions thereto, e.g., in relation to specific requirements and/or in relation to specified mission(s) or process(es). System **100** may calibrate for each user the data display parameters (e.g., number of data items,

density, separation between item) and the cueing schemes and use the calibration results as baseline for user evaluation. The calibration may be carried out at a preparatory stage or during the monitoring of the users.

[0047] As non-limiting examples, mode definitions **164** may relate to aircraft flight modes as exemplified above but in the context of the control center (e.g., relating to accident dangers or to temporal management of an airfield) and operational definitions **166** may relate to the missions performed by different aircrafts and missions handled by the control center itself, e.g., different types of aircrafts involved, reconnaissance and attack missions, missions related to different land or sea regions etc.

[0048] In certain embodiments, managing module **160** in control system **100** may be configured to select, from display-relevant data **80**, a plurality of relevant data, the relevance thereof determined according to user definitions **162**, mode definitions **164** and/or mission definitions **166**, display the relevant data on respective one or more displays **70** of control system **100** and according to user definitions **162**, monitor user reactions to the displayed relevant data, and enhance specific data from the relevant data on display(s) **70** which are selected according to the monitored user reactions with respect to user definitions **162**, mode definitions **164** and/or mission definitions **166**. The enhancing may comprise cueing piece(s) of information from the specific data – e.g., managing module **160** may be further configured to provide an auditory cue related to the cued piece of information with respect to a spatial position thereof on the respective display(s) and/or managing module **160** may be further configured to provide a visual cue associated with the cued piece of information. It is noted that in case of multi-layered information, cueing may be adjusted according to the respective layer of information to which the piece of information belongs (e.g., cues having different colors or different brightness levels may be used to cue stimuli belonging to different layers).

[0049] **Figure 6** is a high level schematic illustration of selection of displayed information, according to some embodiments of the invention. Displayed data on display **70** may comprise different types of information, relating to different contexts. In the illustrated example, the squares, circles and triangles represent aerial vehicles of different types **171A**, **171D**, **171B** and different characters. A user at the control certain may need to address only certain types of aerial vehicles (e.g., ones represented by squares **171A**), and the rest of the aerial vehicles may be removed from the user's display with no adverse effect to the control abilities of the user, and reducing the clutter on display improving the effectiveness of the control and reducing reaction

times and fatigue. In another example, certain information relating to certain type(s) of aerial vehicles may be presented in more detail (see different triangles **171C**) due to the reduction of clutter, improving the information content of display **70** and improving the control abilities of the user.

[0050] **Figure 7** is a high level schematic flowchart illustrating a method **200**, according to some embodiments of the invention. Method **200** may be at least partially implemented by at least one computer processor. Certain embodiments comprise computer program products comprising a computer readable storage medium having computer readable program embodied therewith and configured to carry out the relevant stages of method **200**.

[0051] Method **200** may comprise selecting, from display-relevant data, a plurality of relevant data, the relevance thereof determined according to at least one of user definitions, mode definitions and mission definitions (stage **202**), displaying the relevant data and monitoring user reactions thereto (stage **204**) and enhancing specific data from the relevant data, the enhanced data selected according to the monitored user reactions with respect to the at least one of user definitions, mode definitions and mission definitions (stage **206**). Method **200** may further comprise cueing at least one piece of information from the specific data (stage **212**), e.g., by providing auditory and/or visual cues that are related to the piece(s) of information (stage **214**). For example, method **200** may provide an auditory cue related to the cued piece of information with respect to a spatial position thereof and/or with respect to a predefined relation of auditory cues and information types. In another example, method **200** may provide a visual cue associated with the cued piece of information, e.g., with respect to a spatial relation and/or visual parameter(s) thereof, possibly at a specified interval before displaying the cued piece of information.

[0052] In certain embodiments, method **200** may comprise identifying, from display-relevant data, a piece of information (stage **210**), locating, on a respective display, a display position of the identified piece of information (stage **220**), optionally selecting a visual cue according to visual parameters (e.g., location, color, size, font) of the display-relevant data (stage **230**), and displaying the visual cue at a specified interval (e.g., between 10 and 500ms) prior to displaying the piece of information, at a cue position on the display that has a specified spatial relation to the display position of the piece of information (stage **240**).

[0053] As a non-limiting example, the display may be a pilot display and the display-relevant data and the identified piece of information may relate to an aircraft flown by the pilot. As

another non-limiting example, the display may be a road vehicle display and the display-relevant data and the identified piece of information may relate to the vehicle driven by the user. In certain embodiments, method **200** may further comprise configuring the visual cue according to urgency parameters of the piece of information (stage **232**). Method **200** may comprise configuring the visual cue(s) according to an identified user reaction (stage **234**), e.g., from vehicle feedback, from a user monitoring unit etc.

[0054] In certain embodiments, method **200** may further comprise presenting a plurality of the visual cues according to a specified display scanning scheme (stage **250**).

[0055] In certain embodiments, method **200** may further comprise identifying a display scanning scheme of the pilot (stage **260**) and presenting a plurality of the visual cues to correct the pilot's display scanning scheme with respect to a specified display scanning scheme (stage **265**). Method **200** may further comprise adapting cue selection **230** and display **240** to the identified display scanning scheme (stage **267**).

[0056] In certain embodiments, method **200** may further comprise maintaining a specified period (of at least one second) between repetitions of the visual cue displaying at a specified range of cue positions (stage **270**).

[0057] In certain embodiments, method **200** may further comprise quantifying an attention pattern of a user with respect to the displayed data and visual cues (stage **280**), the attention pattern comprising a spatio-temporal relation of estimated locations of a user's attention to the displayed data and visual cues, relating the quantified attention pattern to recorded reaction times of the user to the displayed data (stage **285**), and modifying spatio-temporal parameters of the visual cues to decrease the user's reaction times according to specified requirements (stage **290**).

[0058] In certain embodiments, method **200** may comprise identifying the user and using collected data to improve the user's use of the display (stage **295**). Any of the method aspects may be applicable to different users and different displays, e.g., to pilots using aircraft displays, drivers using vehicle displays, cellphone users and so forth. At least one of the stages of method **200** may be carried out at one of the stages using a computer processor (stage **340**).

[0059] In certain embodiments, method **200** may comprise managing the information displayed to multiple users of control units (stage **300**), e.g., control center users, monitoring the flow of information in the managed system to identify inattentiveness to specific pieces of information (stage **310**) and adjusting the displayed data and/or the cueing schemes to direct user attentiveness to prioritized pieces of information (stage **320**). In certain embodiments, method

200 may further comprise modifying displayed data according to detected levels of attention of the respective users (stage **322**).

[0060] System **100** and method **200** may be used for training a user to scan the display more efficiently and to enable optimal utilization of the limited attention resources of the user. System **100** and method **200** may be used to manage multiple users that monitor multi-layered information on respective displays in control centers.

[0061] In the above description, an embodiment is an example or implementation of the invention. The various appearances of "one embodiment", "an embodiment", "certain embodiments" or "some embodiments" do not necessarily all refer to the same embodiments.

[0062] Although various features of the invention may be described in the context of a single embodiment, the features may also be provided separately or in any suitable combination. Conversely, although the invention may be described herein in the context of separate embodiments for clarity, the invention may also be implemented in a single embodiment.

[0063] Certain embodiments of the invention may include features from different embodiments disclosed above, and certain embodiments may incorporate elements from other embodiments disclosed above. The disclosure of elements of the invention in the context of a specific embodiment is not to be taken as limiting their use in the specific embodiment alone.

[0064] Furthermore, it is to be understood that the invention can be carried out or practiced in various ways and that the invention can be implemented in certain embodiments other than the ones outlined in the description above.

[0065] The invention is not limited to those diagrams or to the corresponding descriptions. For example, flow need not move through each illustrated box or state, or in exactly the same order as illustrated and described.

[0066] Meanings of technical and scientific terms used herein are to be commonly understood as by one of ordinary skill in the art to which the invention belongs, unless otherwise defined.

[0067] 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 preferred embodiments. Other possible variations, modifications, and applications are also within the scope of the invention. Accordingly, the scope of the invention should not be limited by what has thus far been described, but by the appended claims and their legal equivalents.

CLAIMS

1. A method comprising:

identifying, from display-relevant data, a piece of information,

locating, on a respective display, a display position of the identified piece of information, and

displaying a visual cue at a specified interval prior to displaying the piece of information, at a cue position on the display that has a specified spatial relation to the display position of the piece of information.

2. The method of claim 1, further comprising selecting a visual cue according to visual parameters of the displayed data.
3. The method of claim 1, wherein the display is a vehicle display and wherein the displayed data and the identified piece of information relate to a vehicle driven by a driver.
4. The method of claim 1, wherein the display is a pilot display and wherein the displayed data and the identified piece of information relate to an aircraft flown by a pilot.
5. The method of claim 4, further comprising presenting a plurality of the visual cues according to a specified display scanning scheme.
6. The method of claim 4, further comprising identifying a display scanning scheme of the pilot and presenting a plurality of the visual cues to correct the pilot's display scanning scheme with respect to a specified display scanning scheme.
7. The method of claim 4, further comprising identifying a display scanning scheme of the pilot and adapting the cue selection and display to the identified display scanning scheme.
8. The method of claim 1, further comprising configuring the visual cue according to urgency parameters of the piece of information.
9. The method of claim 1, further comprising configuring the visual cue according to an identified user reaction.
10. The method of claim 1, wherein the specified interval is between 10ms and 500ms.
11. The method of claim 1, further comprising maintaining a period of at least one second between repetitions of the visual cue displaying at a specified range of cue positions.
12. The method of claim 1, further comprising:

quantifying an attention pattern of a user with respect to the displayed data and visual cues, the attention pattern comprising a spatio-temporal relation of estimated locations of a user's attention to the displayed data and visual cues,

relating the quantified attention pattern to recorded reaction times of the user to the displayed data, and

modifying spatio-temporal parameters of the visual cues to decrease the user's reaction times according to specified requirements.

13. A system comprising a cueing module in communication with a display module that operates a display, the cueing module configured to identify, from displayed data, a piece of information, locate a display position of the identified piece of information, select a visual cue according to visual parameters of the displayed data, and instruct the display module to display the visual cue at a specified interval prior to displaying the piece of information, at a cue position on the display that has a specified spatial relation to the display position of the piece of information.
14. The system of claim 13, further comprising the display module and the display.
15. The system of claim 13, wherein the cueing module is further configured to present a plurality of the visual cues according to a specified display scanning scheme.
16. The system of claim 13, wherein the cueing module is further configured to configure the visual cue according to urgency parameters of the piece of information.
17. The system of claim 13, wherein the specified interval is between 0 and 500ms.
18. The system of claim 13, wherein the cueing module is further configured to maintain a specified period between repetitions of the visual cue at a specified range of cue positions.
19. The system of claim 13, further comprising a feedback module in communication with the cueing module and with a monitoring module that monitors a user of the display, the feedback module configured to evaluate an efficiency of the cueing, wherein the cueing module is further configured to modify at least one parameter of the visual cue according to the evaluated efficiency.
20. The system of claim 13, further comprising a training module in communication with the cueing module and with a monitoring module that is configured to identify a display scanning scheme of a user of the display, the training module configured to present a plurality of the visual cues to correct the user's display scanning scheme with respect to a specified display scanning scheme.
21. The system of claim 20, further comprising a quantifying module configured to quantify an attention pattern of a user with respect to the displayed data and visual cues, the attention pattern comprising a spatio-temporal relation of estimated locations of a user's attention to the

displayed data and visual cues, and to relate the quantified interaction pattern to recorded reaction times of the used to the displayed data,

wherein the training module is further configured to modify spatio-temporal parameters of the visual cues to decrease the user's reaction times according to specified requirements.

22. A method comprising:

selecting, from display-relevant data, a plurality of relevant data, the relevance thereof determined according to at least one of user definitions, mode definitions and mission definitions,

displaying the relevant data and monitoring user reactions thereto, and

enhancing specific data from the relevant data, the enhanced data selected according to the monitored user reactions with respect to the at least one of user definitions, mode definitions and mission definitions, wherein the enhancing comprises cueing at least one piece of information from the specific data.

23. The method of claim [[23]]22, wherein the cueing comprising providing an auditory cue related to the cued piece of information with respect to a spatial position thereof.

24. The method of claim [[23]]22, wherein the cueing comprising providing an auditory cue related to the cued piece of information with respect to a predefined relation of auditory cues and information types.

25. The method of claim [[23]]22, wherein the cueing comprises providing a visual cue associated with the cued piece of information.

26. The method of claim 26, wherein the association is with respect to at least one of a spatial relation and at least one visual parameter.

27. The method of claim 26, wherein the visual cue is provided at a specified interval before displaying the cued piece of information.

28. A managing module in a control system, the managing module configured to:

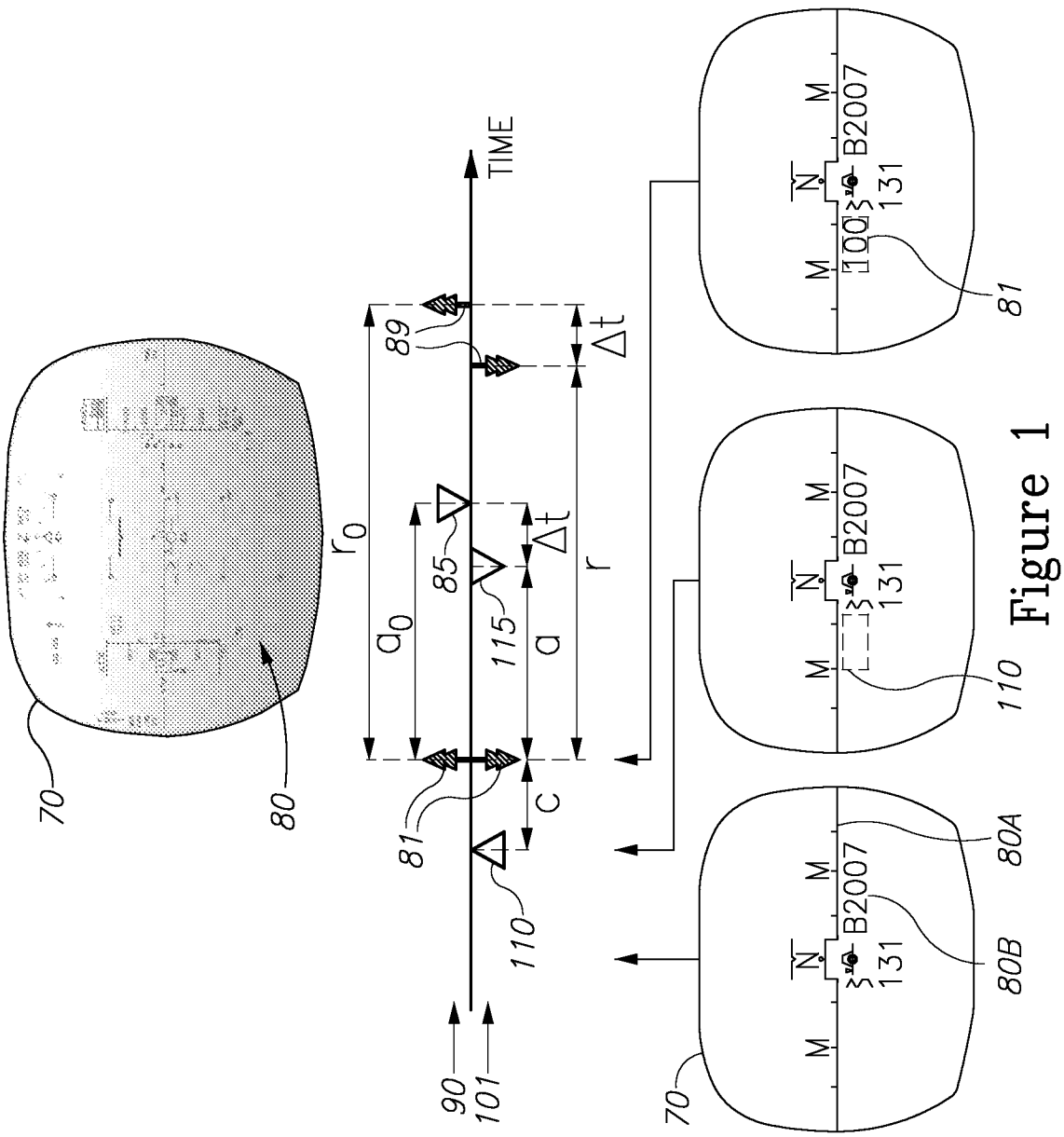
select, from display-relevant data, a plurality of relevant data, the relevance thereof determined according to at least one of user definitions, mode definitions and mission definitions,

display the relevant data on respective one or more displays of the control system and according to the user definitions,

monitor user reactions to the displayed relevant data, and

enhance specific data from the relevant data on the respective one or more displays of the control system, the enhanced data selected according to the monitored user reactions with respect to the at least one of user definitions, mode definitions and mission definitions, wherein the enhancing comprises cueing at least one piece of information from the specific data.

29. The managing module of claim 29, further configured to provide an auditory cue related to the cued piece of information with respect to a spatial position thereof on the respective one or more displays of the control system.
30. The managing module of claim 29, further configured to provide a visual cue associated with the cued piece of information.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81
89
85
115
110
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a_0
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r
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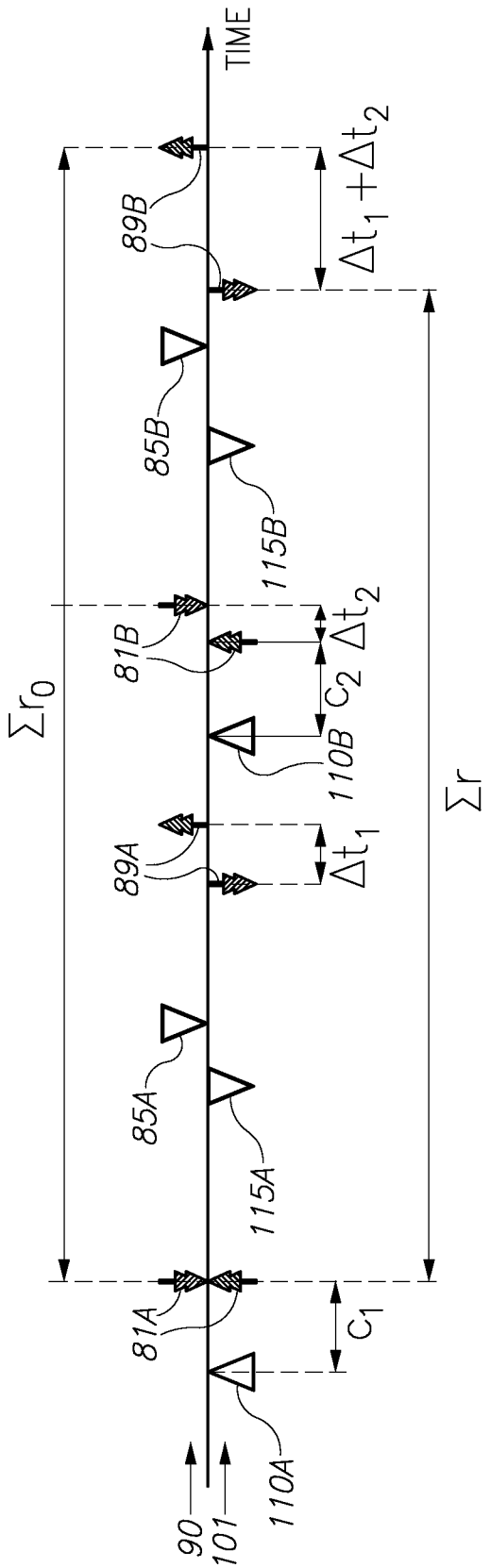
Δt
B2007
131
80A
80B
110
81
70

Figure 1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$\Delta t_1 + \Delta t_2$
85B
115B
81B
Σr_0
Δt_2
c_2
110B
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89A
Σr
85A
115A
81A
c_1
110A
90
101

Figure 2

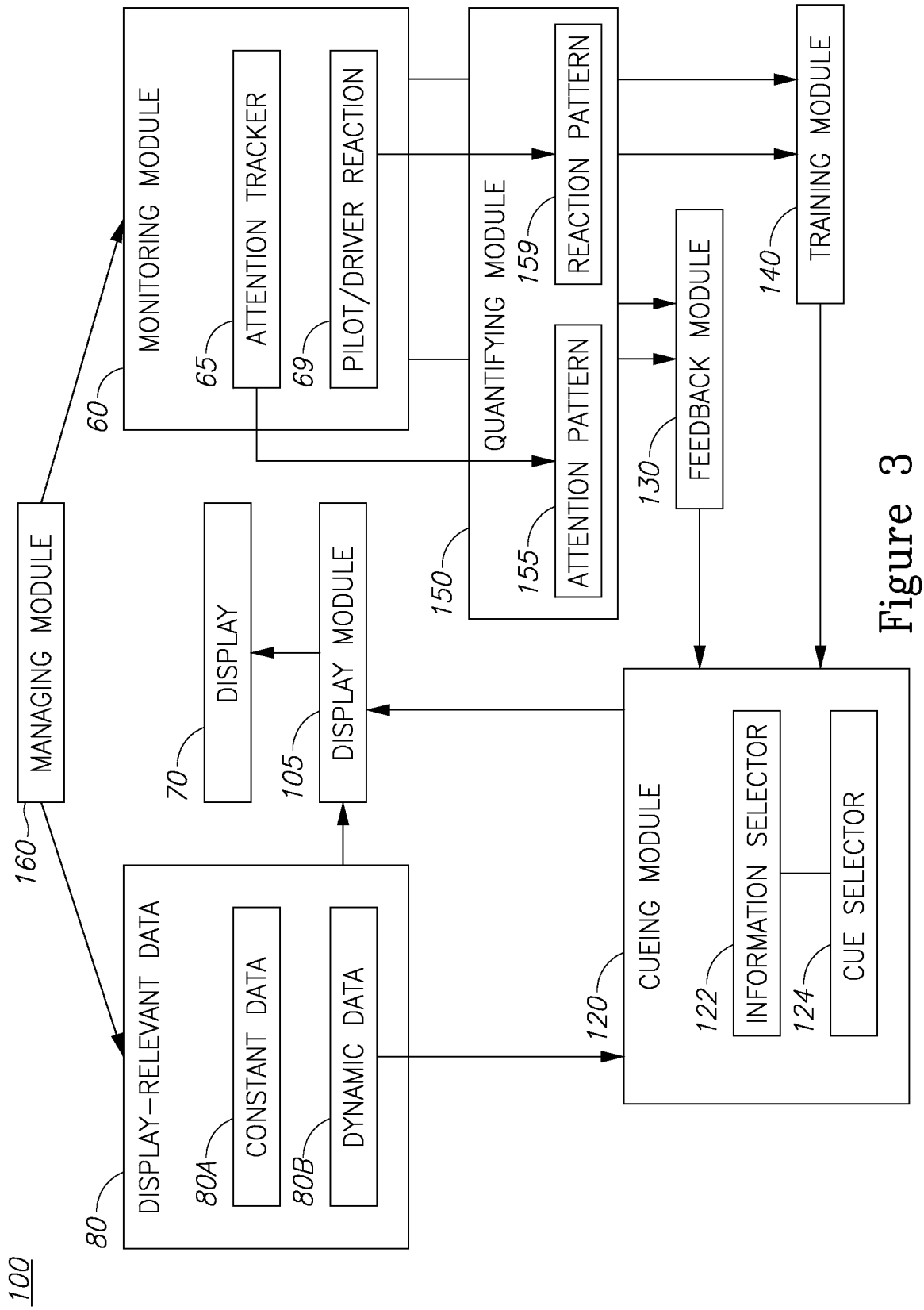
100
MANAGING MODULE
160
MONITORING MODULE
60
ATTENTION TRACKER
65
PILOT/DRIVER REACTION
69
QUANTIFYING MODULE
150
REACTION PATTERN
159
ATTENTION PATTERN
155
TRAINING MODULE
140
FEEDBACK MODULE
130
DISPLAY
70
DISPLAY MODULE
105
DISPLAY-RELEVANT DATA
80
CONSTANT DATA
80A
DYNAMIC DATA
80B
CUEING MODULE
120
INFORMATION SELECTOR
122
CUE SELECTOR
124

Figure 3

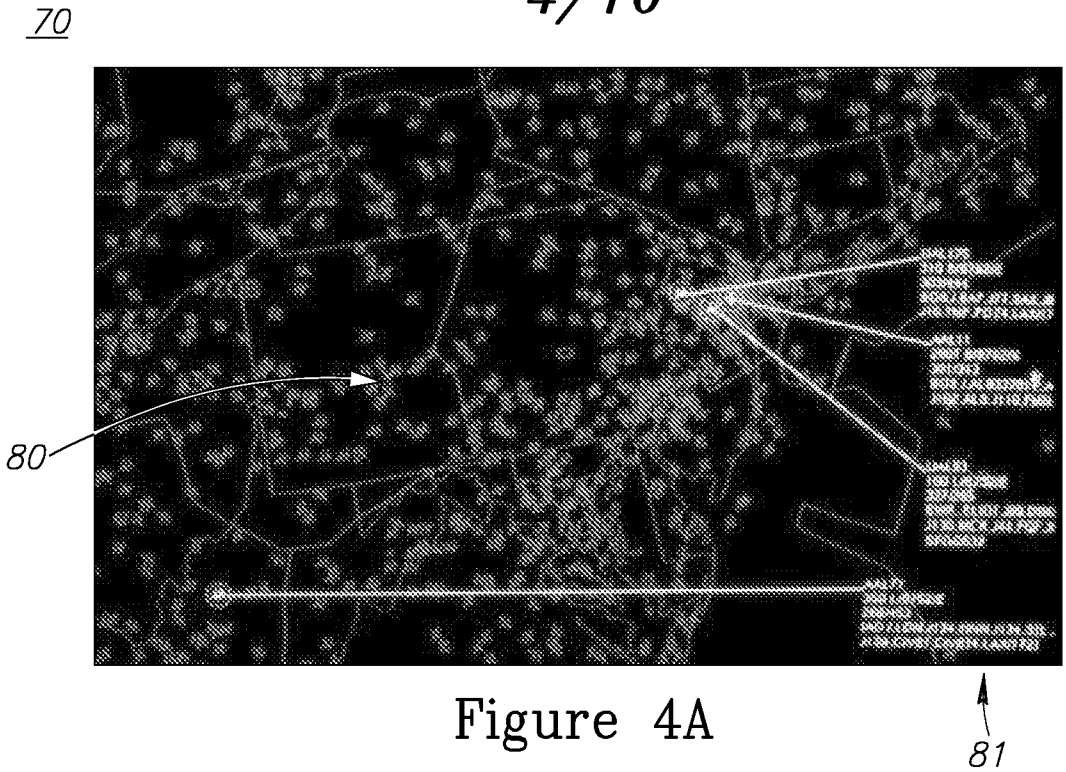

Figure 4A

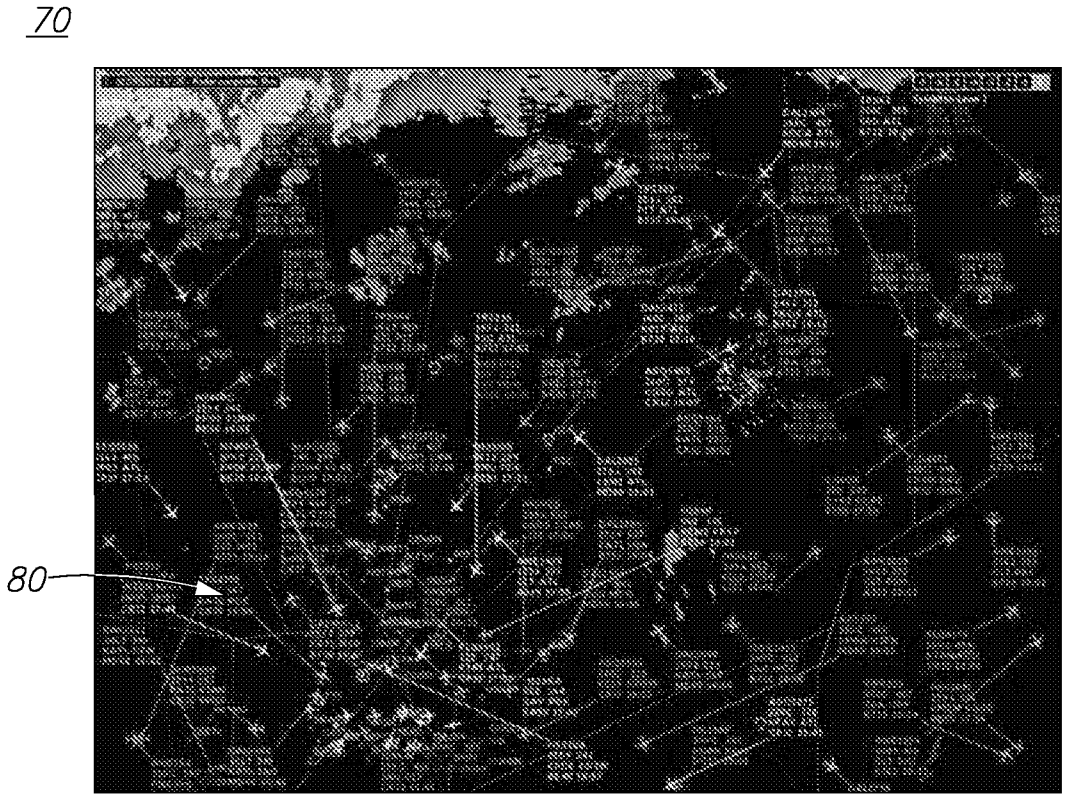

Figure 4B

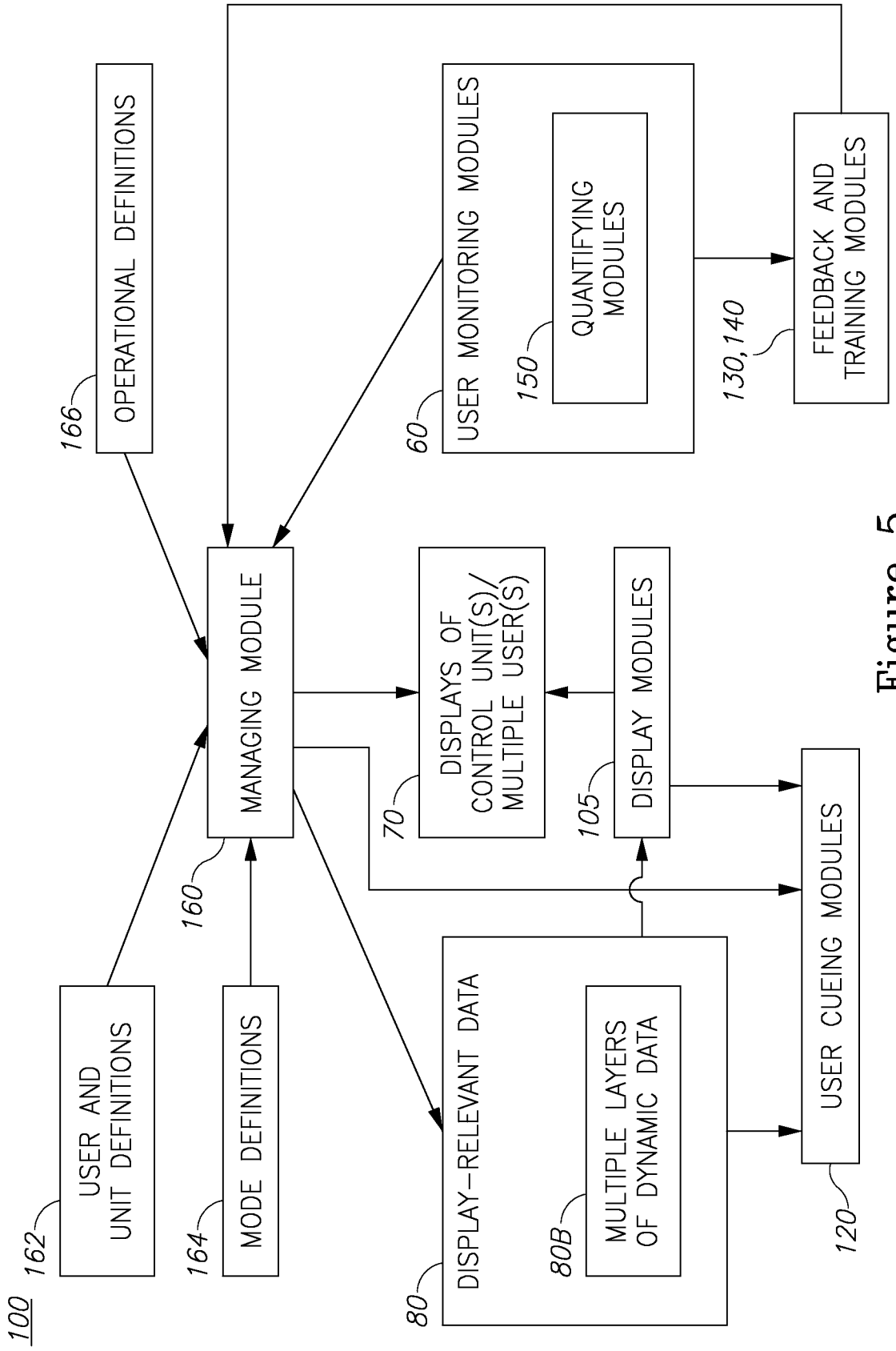
100
USER AND UNIT DEFINITIONS
162
MODE DEFINITIONS
164
OPERATIONAL DEFINITIONS
166
MANAGING MODULE
160
USER MONITORING MODULES
60
QUANTIFYING MODULES
150
FEEDBACK AND TRAINING MODULES
130,140
DISPLAYS OF CONTROL UNIT(S)/ MULTIPLE USER(S)
70
DISPLAY MODULES
105
DISPLAY-RELEVANT DATA
80
MULTIPLE LAYERS OF DYNAMIC DATA
80B
USER CUEING MODULES
120

Figure 5

70

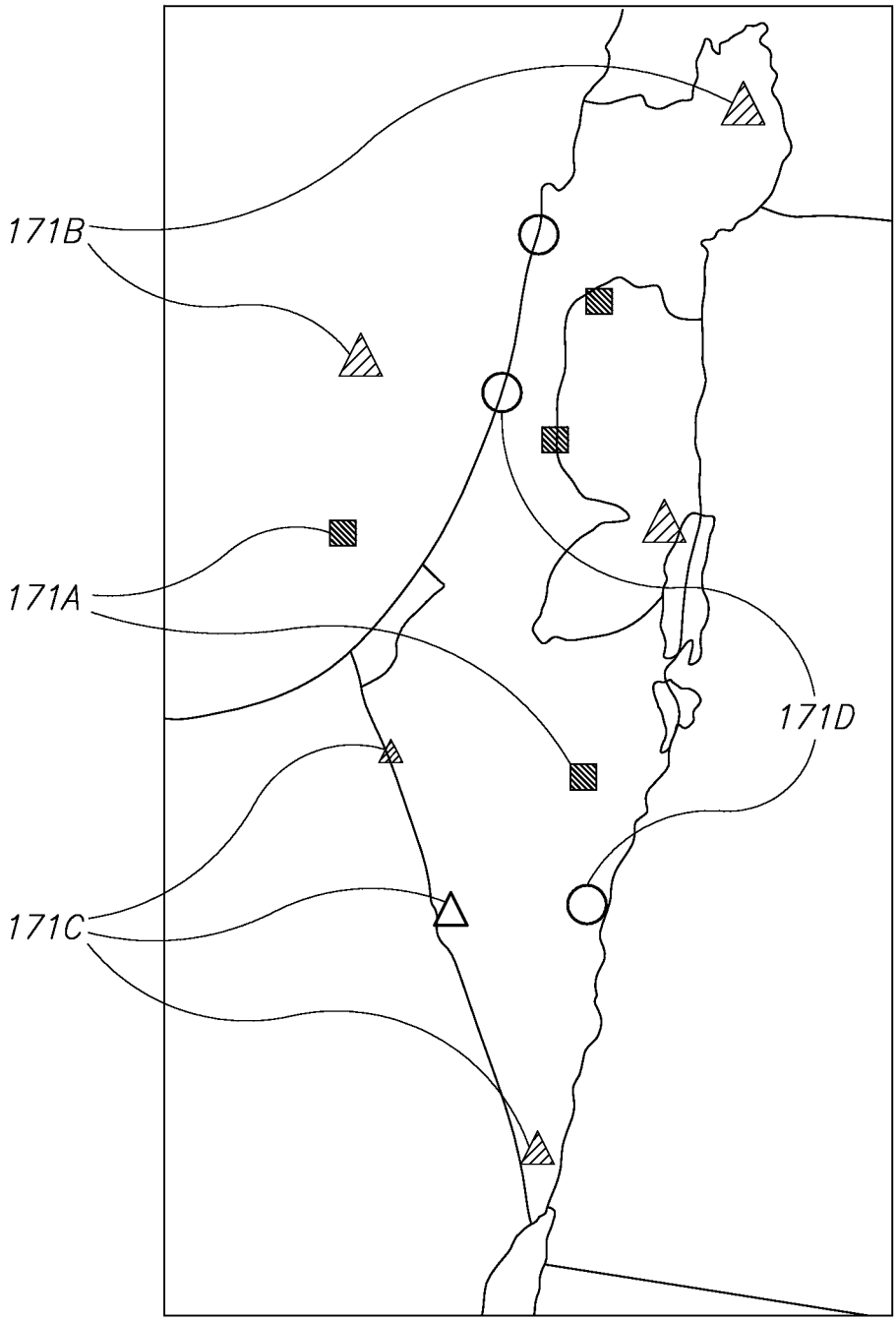

Figure 6

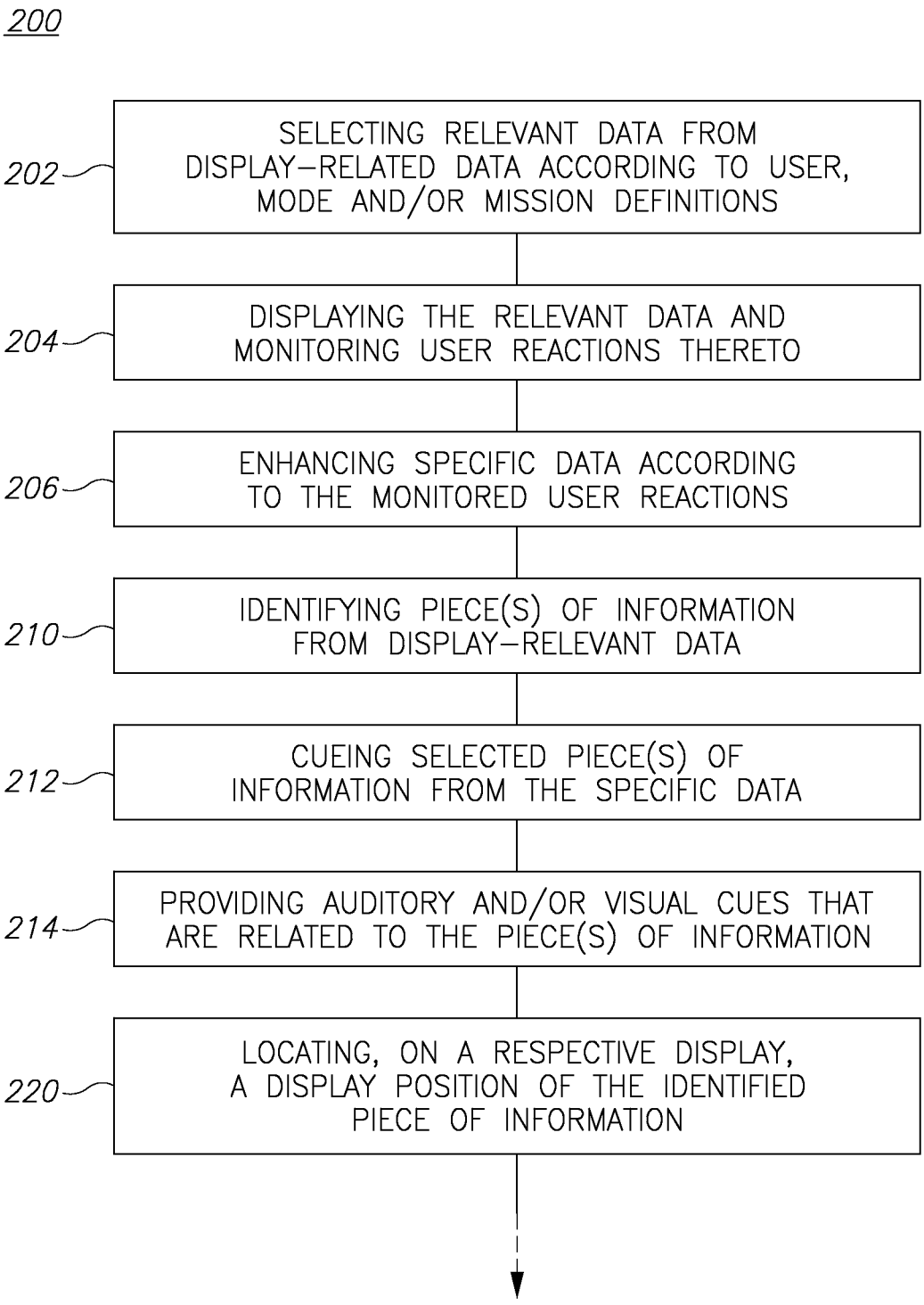
200
202
SELECTING RELEVANT DATA FROM DISPLAY-RELATED DATA ACCORDING TO USER, MODE AND/OR MISSION DEFINITIONS
204
DISPLAYING THE RELEVANT DATA AND MONITORING USER REACTIONS THERETO
206
ENHANCING SPECIFIC DATA ACCORDING TO THE MONITORED USER REACTIONS
210
IDENTIFYING PIECE(S) OF INFORMATION FROM DISPLAY-RELEVANT DATA
212
CUEING SELECTED PIECE(S) OF INFORMATION FROM THE SPECIFIC DATA
214
PROVIDING AUDITORY AND/OR VISUAL CUES THAT ARE RELATED TO THE PIECE(S) OF INFORMATION
220
LOCATING, ON A RESPECTIVE DISPLAY, A DISPLAY POSITION OF THE IDENTIFIED PIECE OF INFORMATION

Figure 7

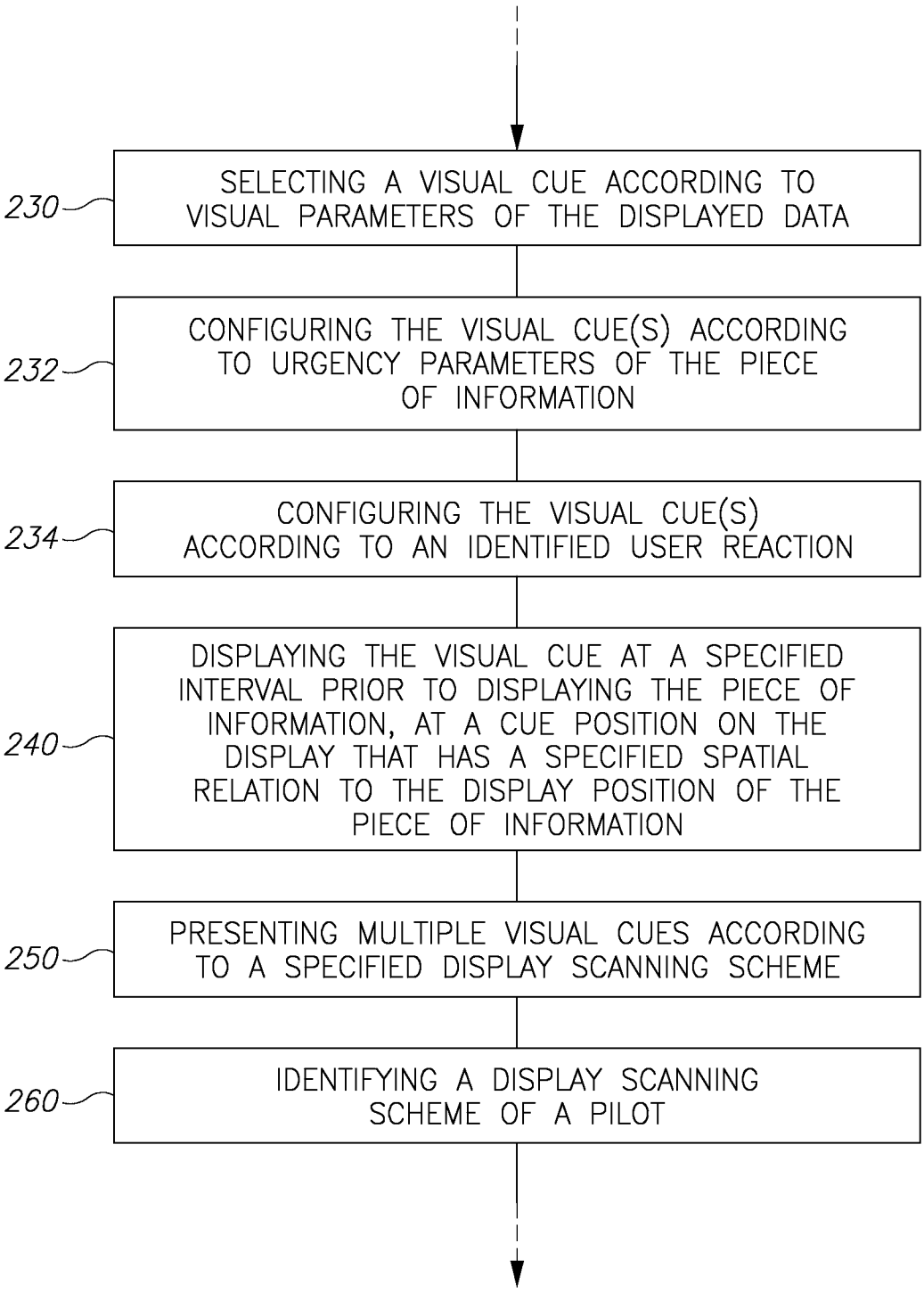

Figure 7 (cont. 1)

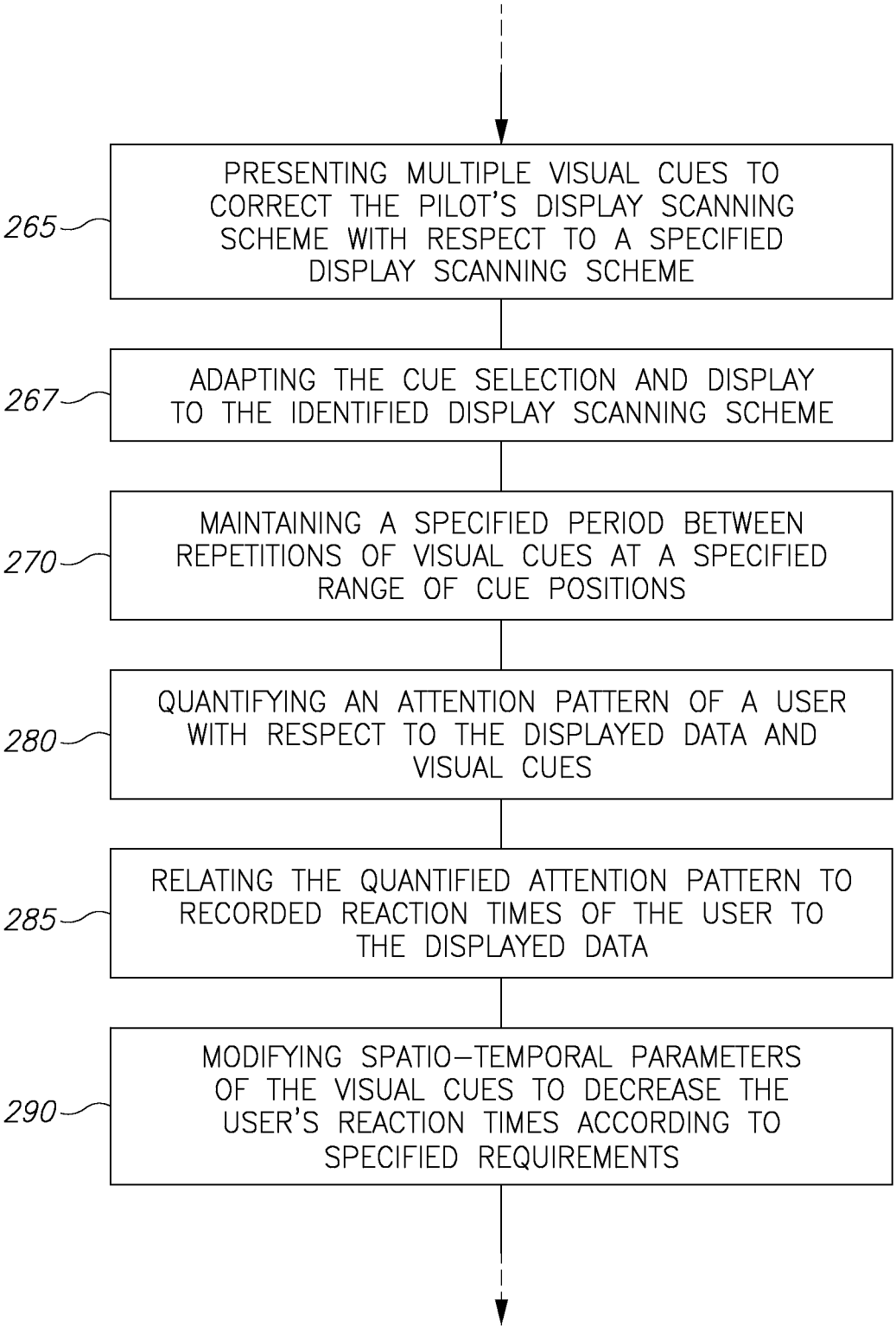

Figure 7 (cont. 2)

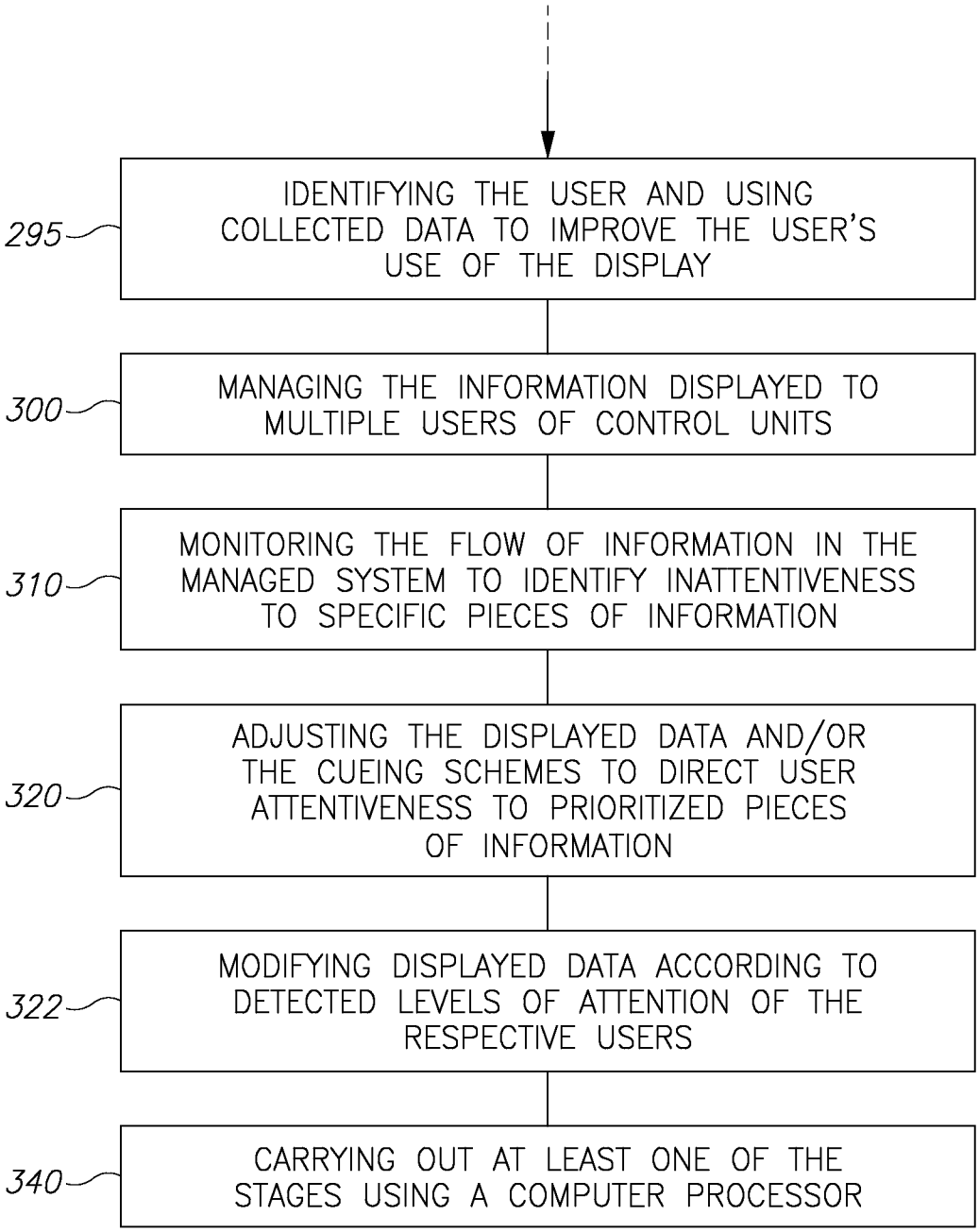

Figure 7 (cont. 3)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL2016/050993

A. CLASSIFICATION OF SUBJECT MATTER
IPC (2016.01) G06F 3/13, G01C 23/00

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 (2016.01) G06F 3/13, G01C 23/00

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: Esp@cenet, Google Patents, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Attention and the Detection of Signals, Journal of experimental psychology,Vol.109, No.2, pages:160-174 Michael I.Posner et al. 31 Dec 1980 (1980/12/31) the whole document	1-11,13-18
A	the whole document	12,19-30
Y	US 7834779 B2 He et al. 16 Nov 2010 (2010/11/16) the whole document	1-11,13-18
A	the whole document	12,19-30
Y	WO 2014110437 A1 LIU Kexi 17 Jul 2014 (2014/07/17) the whole document	9

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents:
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"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
26 Dec 2016	27 Dec 2016
Name and mailing address of the ISA: Israel Patent Office Technology Park, Bldg.5, Malcha, Jerusalem, 9695101, Israel Facsimile No. 972-2-5651616	Authorized officer Al-Muhannad Rafa Telephone No. 972-2-5651751

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL2016/050993

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	IMPROVING VISUAL SEARCH PERFORMANCE IN AUGMENTED REALITY ENVIRONMENTS USING A SUBTLE CUEING APPROACH:EXPERIMENTAL METHODS, APPARATUS DEVELOPMENT AND EVALUATION LU WEIQUAN 31 Dec 2013 (2013/12/31) the whole document	1-30

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IL2016/050993

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
US 7834779 B2	16 Nov 2010	US 2009207048 A1	20 Aug 2009
		US 7834779 B2	16 Nov 2010
		EP 1946045 A2	23 Jul 2008
		EP 1946045 B1	11 Nov 2015
		WO 2008060260 A2	22 May 2008
		WO 2008060260 A3	14 Aug 2008
WO 2014110437 A1	17 Jul 2014	WO 2014110437 A1	17 Jul 2014
		CN 104937519 A	23 Sep 2015
		EP 2943853 A1	18 Nov 2015
		JP 2016503217 A	01 Feb 2016
		KR 20150107781 A	23 Sep 2015
		US 2014198129 A1	17 Jul 2014