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(54) CONTROL OF AUDIO RENDERING

(57) A method comprising: detecting a change in position of rendering a sound object from a first position at a first time to a second position, different to the first position, at a second time immediately after the first time; and at the second time, generating a visual distraction.

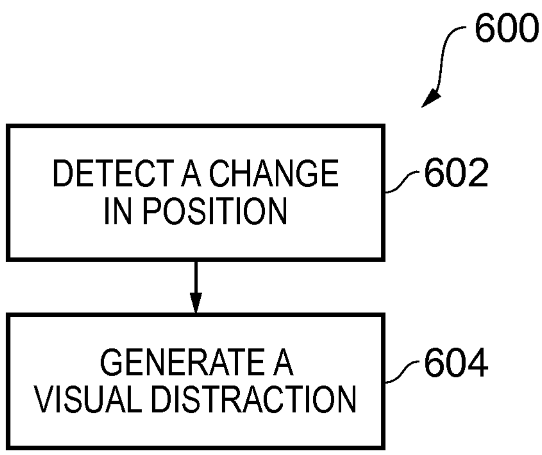

FIG. 10

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Description

TECHNOLOGICAL FIELD

[0001] Embodiments of the present invention relate to control of audio rendering. In particular, they relate to control of audio rendering of a sound scene comprising at least one sound object.

BACKGROUND

[0002] A sound scene in this document is used to refer to the arrangement of one or more sound sources in a three-dimensional space. When a sound source changes position, the sound scene changes. When the sound source changes its audio properties such as its audio output, then the sound scene changes.

[0003] A sound scene may be defined in relation to recording sounds (a recorded sound scene) and in relation to rendering sounds (a rendered sound scene).

[0004] Some current technology focuses on accurately reproducing a recorded sound scene as a rendered sound scene either in real time or at a distance in time and/or space from the recorded sound scene. The recorded sound scene is encoded for storage and/or transmission and/or rendering.

[0005] A sound object within a sound scene may be a source sound object that represents a sound source within the sound scene or may be a recorded sound object which represents sounds recorded at a particular microphone. In this document, reference to a sound object refers to both a recorded sound object and a source sound object. However, in some examples, the sound object(s) may be only source sound objects and in other examples the sound object(s) may be only recorded sound objects.

[0006] By using audio processing it may be possible, in some circumstances, to convert a recorded sound object into a source sound object and/or to convert a source sound object into a recorded sound object.

[0007] It may be desirable in some circumstances to record a sound scene using multiple microphones. Some microphones, such as Lavalier microphones, or other portable microphones, may be attached to or may follow a sound source in the sound scene. Other microphones may be static in the sound scene.

[0008] The combination of outputs from the various microphones defines a recorded sound scene. However, it may not always be possible to render the sound scene exactly as it was when it was recorded.

BRIEF SUMMARY

[0009] According to various, but not necessarily all, embodiments of the invention there is provided a method comprising: detecting a change in position of rendering a sound object from a first position at a first time to a second position, different to the first position, at a second time immediately after the first time; and at the second time, generating a visual distraction.

[0010] According to various, but not necessarily all, embodiments of the invention there is provided a computer program when run on a processor causes performance of:

detecting a change in position of rendering a sound object from a first position at a first time to a second position, different to the first position, at a second time immediately after the first time; and at the second time, generating a visual distraction.

[0011] According to various, but not necessarily all, embodiments of the invention there is provided a system or apparatus comprising means for performing: detecting a change in position of rendering a sound object from a first position at a first time to a second position, different to the first position, at a second time immediately after the first time; and at the second time, generating a visual distraction.

[0012] According to various, but not necessarily all, embodiments of the invention there is provided an apparatus comprising: at least one processor; and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to perform: detecting a change in position of rendering a sound object from a first position at a first time to a second position, different to the first position, at a second time immediately after the first time; and at the second time, generating a visual distraction.

[0013] According to various, but not necessarily all, embodiments of the invention there is provided examples as claimed in the appended claims.

BRIEF DESCRIPTION

[0014] For a better understanding of various examples that are useful for understanding the detailed description, reference will now be made by way of example only to the accompanying drawings in which:

Fig. 1 illustrates an example of a system and also an example of a method for recording and encoding a sound scene;

Fig. 2 schematically illustrates relative positions of a portable microphone (PM) and static microphone (SM) relative to an arbitrary reference point (REF);

Fig. 3 illustrates a system as illustrated in Fig. 1, modified to rotate the rendered sound scene relative to the recorded sound scene;

Figs. 4A and 4B illustrate a change in relative orientation between a listener and the rendered sound scene so that the rendered sound scene remains fixed in space;

Fig. 5 illustrates a module which may be used, for example, to perform the functions of the positioning block, orientation block and distance block of the system;

Fig. 6A and 6B illustrate examples of a direct processing block and an indirect processing block for use in the module of Fig. 5;

Fig. 7 illustrates an example of the system implemented using an apparatus;

Fig. 8A and 8B illustrate an example of a first mode of operation of the system;

Fig. 9A and 9B illustrate an example of a second mode of operation of the system;

Fig. 10 illustrates an example of a method;

Figs. 11A, 11B and 11C illustrate an example of a sound scene visually modified by the method of Fig 10; and

Figs. 11A, 11B and 11C illustrate an example of a sound scene visually modified by the method of Fig 10.

DETAILED DESCRIPTION

[0015] Fig. 1 illustrates an example of a system 100 and also an example of a method 200. The system 100 and method 200 record a sound scene 10 and process the recorded sound scene to enable an accurate rendering of the recorded sound scene as a rendered sound scene for a listener at a particular position (the origin) within the recorded sound scene 10.

[0016] The system 100 comprises one or more portable microphones 110 and may comprise one or more static microphones 120.

[0017] In this example, but not necessarily all examples, the origin of the sound scene is at a microphone. In this example, the microphone at the origin is a static microphone 120. It may record one or more channels, for example it may be a microphone array.

[0018] In this example, only a single static microphone 120 is illustrated. However, in other examples multiple static microphones 120 may be used independently. In such circumstances the origin may be at any one of these static microphones 120 and it may be desirable to switch, in some circumstances, the origin between static microphones 120 or to position the origin at an arbitrary position within the sound scene.

[0019] The system 100 comprises one or more portable microphones 110. The portable microphone 110 may, for example, move with a sound source within the recorded sound scene 10. The portable microphone may, for example, be an 'up-close' microphone that remains close to a sound source. This may be achieved, for example, using a boom microphone or, for example, by attaching the microphone to the sound source, for example, by using a Lavalier microphone. The portable microphone 110 may record one or more recording channels.

[0020] Fig. 2 schematically illustrates the relative positions of the portable microphone (PM) 110 and the static microphone (SM) 120 (if present) relative to an arbitrary reference point (REF). The position of the static microphone 120 relative to the reference point REF is represented by the vector $\underline{\mathbf{x}}$. The position of the portable microphone PM relative to the reference point REF is represented by the vector $\underline{\mathbf{y}}$. The relative position of the portable microphone PM 110 from the static microphone SM 120 is represented by the vector $\underline{\mathbf{z}}$. It will be understood that $\underline{\mathbf{z}} = \underline{\mathbf{y}} - \underline{\mathbf{x}}$. The vector $\underline{\mathbf{z}}$ gives the relative position of the portable microphone 110 relative to the static microphone 120 which, in this example, is the origin of the sound scene 10. The vector $\underline{\mathbf{z}}$ therefore positions the portable microphone 110 relative to a notional listener of the recorded sound scene 10. As the origin is static, the vector $\underline{\mathbf{x}}$ is constant. Therefore, if one has knowledge of $\underline{\mathbf{x}}$ and tracks variations in $\underline{\mathbf{y}}$, it is possible to also track variations in $\underline{\mathbf{z}}$, the relative position of the portable microphone 110 relative to the origin of the sound scene 10.

[0021] When the sound scene 10 as recorded is rendered to a user (listener) by the system 100 in Fig. 1, it is rendered to the listener as if the listener is positioned at the origin of the recorded sound scene 10. It is therefore important that, as the portable microphone 110 moves in the recorded sound scene 10, its position $\underline{\mathbf{z}}$ relative to the origin of the recorded sound scene 10 is tracked and is correctly represented in the rendered sound scene. The system 100 is configured to achieve this.

[0022] In the example of Fig. 1, the audio signals 122 output from the static microphone 120 are coded by audio coder 130 into a multichannel audio signal 132. If multiple static microphones were present, the output of each would be separately coded by an audio coder into a multichannel audio signal.

[0023] The audio coder 130 may be a spatial audio coder such that the multichannels 132 represent the sound scene 10 as recorded by the static microphone 120 and can be rendered giving a spatial audio effect. For example, the audio coder 130 may be configured to produce multichannel audio signals 132 according to a defined standard such as, for example, binaural coding, 5.1 surround sound coding, 7.1 surround sound coding etc. If multiple static microphones were present, the multichannel signal of each static microphone would be produced according to the same defined standard such as, for example, binaural coding, 5.1 surround sound coding, and 7.1 surround sound coding and in relation to the same common rendered sound scene.

[0024] The multichannel audio signals 132 from one or more the static microphones 120 are mixed by mixer 102 with multichannel audio signals 142 from the one or more portable microphones 110 to produce a multi-microphone multichannel audio signal 103 that represents the recorded sound scene 10 relative to the origin and which can be rendered by an audio decoder corresponding to the audio coder 130 to reproduce a rendered sound scene to a listener that corresponds to the recorded sound scene when the listener is at the origin.

[0025] The multichannel audio signal 142 from the, or each, portable microphone 110 is processed before mixing to take account of any movement of the portable microphone 110 relative to the origin at the static microphone 120.

[0026] The audio signals 112 output from the portable microphone 110 are processed by the positioning block 140 to adjust for movement of the portable microphone 110 relative to the origin. The positioning block 140 takes as an input the vector $\underline{\mathbf{z}}$ or some parameter or parameters dependent upon the vector $\underline{\mathbf{z}}$. The vector $\underline{\mathbf{z}}$ represents the relative position of the portable microphone 110 relative to the origin at the static microphone 120 in this example.

[0027] The positioning block 140 may be configured to adjust for any time misalignment between the audio signals 112 recorded by the portable microphone 110 and the audio signals 122 recorded by the static microphone 120 so that they share a common time reference frame. This may be achieved, for example, by correlating naturally occurring or artificially introduced (non-audible) audio signals that are present within the audio signals 112 from the portable microphone 110 with those within the audio signals 122 from the static microphone 120. Any timing offset identified by the correlation may be used to delay/advance the audio signals 112 from the portable microphone 110 before processing by the positioning block 140.

[0028] The positioning block 140 processes the audio signals 112 from the portable microphone 110, taking into account the relative orientation (Arg($\underline{\mathbf{z}}$)) of that portable microphone 110 relative to the origin at the static microphone 120.

[0029] The audio coding of the static microphone audio signals 122 to produce the multichannel audio signal 132 assumes a particular orientation of the rendered sound scene relative to an orientation of the recorded sound scene and the audio signals 122 are encoded to the multichannel audio signals 132 accordingly.

[0030] The relative orientation Arg ($\underline{\mathbf{z}}$) of the portable microphone 110 in the recorded sound scene 10 is determined and the audio signals 112 representing the sound object are coded to the multichannels defined by the audio coding 130 such that the sound object is correctly oriented within the rendered sound scene at a relative orientation Arg ($\underline{\mathbf{z}}$) from the listener. For example, the audio signals 112 may first be mixed or encoded into the multichannel signals 142 and then a transformation T may be used to rotate the multichannel audio signals 142, representing the moving sound object, within the space defined by those multiple channels by Arg ($\underline{\mathbf{z}}$).

[0031] Referring to Figs. 4A and 4B, in some situations, for example when the sound scene is rendered to a listener through a head-mounted audio output device 300, for example headphones using binaural audio coding, it may be desirable for the rendered sound scene 310 to remain fixed in space 320 when the listener turns their head 330 in space. This means that the rendered sound scene 310 needs to be rotated relative to the audio output device 300 by the same amount in the opposite sense to the head rotation.

[0032] In Figs. 4A and 4B, the relative orientation between the listener and the rendered sound scene 310 is represented by an angle θ. The sound scene is rendered by the audio output device 300 which physically rotates in the space 320. The relative orientation between the audio output device 300 and the rendered sound scene 310 is represented by an angle α. As the audio output device 300 does not move relative to the user's head 330 there is a fixed offset between θ and α of 90° in this example. When the user turns their head θ changes. If the sound scene is to be rendered as fixed in space then α must change by the same amount in the same sense.

[0033] Moving from Fig. 4A to 4B, the user turns their head clockwise increasing θ by magnitude Δ and increasing α by magnitude Δ. The rendered sound scene is rotated relative to the audio device in an anticlockwise direction by magnitude Δ so that the rendered sound scene 310 remains fixed in space.

[0034] The orientation of the rendered sound scene 310 tracks with the rotation of the listener's head so that the orientation of the rendered sound scene 310 remains fixed in space 320 and does not move with the listener's head 330.

[0035] Fig. 3 illustrates a system 100 as illustrated in Fig. 1, modified to rotate the rendered sound scene 310 relative to the recorded sound scene 10. This will rotate the rendered sound scene 310 relative to the audio output device 300 which has a fixed relationship with the recorded sound scene 310.

[0036] An orientation block 150 is used to rotate the multichannel audio signals 142 by Δ, determined by rotation of the user's head.

[0037] Similarly, an orientation block 150 is used to rotate the multichannel audio signals 132 by Δ, determined by rotation of the user's head.

[0038] The functionality of the orientation block 150 is very similar to the functionality of the orientation function of the positioning block 140.

[0039] The audio coding of the static microphone signals 122 to produce the multichannel audio signals 132 assumes a particular orientation of the rendered sound scene relative to the recorded sound scene. This orientation is offset by Δ. Accordingly, the audio signals 122 are encoded to the multichannel audio signals 132 and the audio signals 112 are encoded to the multichannel audio signals 142 accordingly. The transformation T may be used to rotate the multichannel audio signals 132 within the space defined by those multiple channels by Δ. An additional transformation T may be used to rotate the multichannel audio signals 142 within the space defined by those multiple channels by Δ.

[0040] In the example of Fig. 3, the portable microphone signals 112 are additionally processed to control the perception of the distance D of the sound object from the listener in the rendered sound scene, for example, to match the distance $|\underline{\mathbf{z}}|$ of the sound object from the origin in the recorded sound scene 10. This can be useful when binaural coding is used so that the sound object is, for example, externalized from the user and appears to be at a distance rather than within the user's head, between the user's ears. The distance block 160 processes the multichannel audio signal 142 to modify the perception of distance.

[0041] Fig. 5 illustrates a module 170 which may be used, for example, to perform the functions of the positioning block 140, orientation block 150 and distance block 160 in Fig. 3. The module 170 may be implemented using circuitry and/or programmed processors.

[0042] The Figure illustrates the processing of a single channel of the multichannel audio signal 142 before it is mixed with the multichannel audio signal 132 to form the multi-microphone multichannel audio signal 103. A single input channel of the multichannel signal 142 is input as signal 187.

[0043] The input signal 187 passes in parallel through a "direct" path and one or more "indirect" paths before the outputs from the paths are mixed together, as multichannel signals, by mixer 196 to produce the output multichannel signal 197. The output multichannel signal 197, for each of the input channels, are mixed to form the multichannel audio signal 142 that is mixed with the multichannel audio signal 132.

[0044] The direct path represents audio signals that appear, to a listener, to have been received directly from an audio source and an indirect path represents audio signals that appear to a listener to have been received from an audio source via an indirect path such as a multipath or a reflected path or a refracted path.

[0045] The distance block 160 by modifying the relative gain between the direct path and the indirect paths, changes the perception of the distance D of the sound object from the listener in the rendered sound scene 310.

[0046] Each of the parallel paths comprises a variable gain device 181, 191 which is controlled by the distance block 160.

[0047] The perception of distance can be controlled by controlling relative gain between the direct path and the indirect (decorrelated) paths. Increasing the indirect path gain relative to the direct path gain increases the perception of distance.

[0048] In the direct path, the input signal 187 is amplified by variable gain device 181, under the control of the distance block 160, to produce a gain-adjusted signal 183. The gain-adjusted signal 183 is processed by a direct processing module 182 to produce a direct multichannel audio signal 185.

[0049] In the indirect path, the input signal 187 is amplified by variable gain device 191, under the control of the distance block 160, to produce a gain-adjusted signal 193. The gain-adjusted signal 193 is processed by an indirect processing module 192 to produce an indirect multichannel audio signal 195.

[0050] The direct multichannel audio signal 185 and the one or more indirect multichannel audio signals 195 are mixed in the mixer 196 to produce the output multichannel audio signal 197.

[0051] The direct processing block 182 and the indirect processing block 192 both receive direction of arrival signals 188. The direction of arrival signal 188 gives the orientation $\mathrm{Arg}(\underline{\mathbf{z}})$ of the portable microphone 110 (moving sound object) in the recorded sound scene 10 and the orientation Δ of the rendered sound scene 310 relative to the audio output device 300.

[0052] The position of the moving sound object changes as the portable microphone 110 moves in the recorded sound scene 10 and the orientation of the rendered sound scene 310 changes as the head-mounted audio output device, rendering the sound scene rotates.

[0053] The direct processing block 182 may, for example, include a system 184 similar to that illustrated in Figure 6A that rotates the single channel audio signal, gain-adjusted input signal 183, in the appropriate multichannel space producing the direct multichannel audio signal 185.

[0054] The system 184 uses a transfer function to performs a transformation T that rotates multichannel signals within the space defined for those multiple channels by $\mathrm{Arg}(\underline{\mathbf{z}})$ and by Δ, defined by the direction of arrival signal 188. For example, a head related transfer function (HRTF) interpolator may be used for binaural audio. As another example, Vector Base Amplitude Panning (VBAP) may be used for loudspeaker format (e.g. 5.1) audio.

[0055] The indirect processing block 192 may, for example, be implemented as illustrated in Fig. 6B. In this example, the direction of arrival signal 188 controls the gain of the single channel audio signal, the gain-adjusted input signal 193, using a variable gain device 194. The amplified signal is then processed using a static decorrelator 196 and then a system 198 that applies a static transformation T to produce the indirect multichannel audio signal 195. The static decorrelator in this example uses a pre-delay of at least 2 ms. The transformation T rotates multichannel signals within the space defined for those multiple channels in a manner similar to the system 184 but by a fixed amount. For example, a static head related transfer function (HRTF) interpolator may be used for binaural audio.

[0056] It will therefore be appreciated that the module 170 can be used to process the portable microphone signals 112 and perform the functions of:

(i) changing the relative position (orientation $\mathrm{Arg}(\underline{\mathbf{z}})$ and/or distance $|\underline{\mathbf{z}}|$) of a sound object, represented by a portable microphone audio signal 112, from a listener in the rendered sound scene and

(ii) changing the orientation of the rendered sound scene (including the sound object positioned according to (i)) relative to a rotating rendering audio output device 300.

[0057] It should also be appreciated that the module 170 may also be used for performing the function of the orientation block 150 only, when processing the audio signals 122 provided by the static microphone 120. However, the direction of arrival signal will include only Δ and will not include Arg(**z**). In some but not necessarily all examples, gain of the variable gain devices 191 modifying the gain to the indirect paths may be put to zero and the gain of the variable gain device 181 for the direct path may be fixed. In this instance, the module 170 reduces to the system 184 illustrated in Fig. 6A that rotates the recorded sound scene to produce the rendered sound scene according to a direction of arrival signal that includes only Δ and does not include Arg(**z**).

[0058] Fig. 7 illustrates an example of the system 100 implemented using an apparatus 400. The apparatus 400 may, for example, be a static electronic device, a portable electronic device or a hand-portable electronic device that has a size that makes it suitable to carried on a palm of a user or in an inside jacket pocket of the user.

[0059] In this example, the apparatus 400 comprises the static microphone 120 as an integrated microphone but does not comprise the one or more portable microphones 110 which are remote. In this example, but not necessarily all examples, the static microphone 120 is a microphone array. However, in other examples, the apparatus 400 does not comprise the static microphone 120.

[0060] The apparatus 400 comprises an external communication interface 402 for communicating externally with external microphones, for example, the remote portable microphone(s) 110. This may, for example, comprise a radio transceiver.

[0061] A positioning system 450 is illustrated as part of the system 100. This positioning system 450 is used to position the portable microphone(s) 110 relative to the origin of the sound scene e.g. the static microphone 120. In this example, the positioning system 450 is illustrated as external to both the portable microphone 110 and the apparatus 400. It provides information dependent on the position **z** of the portable microphone 110 relative to the origin of the sound scene to the apparatus 400. In this example, the information is provided via the external communication interface 402, however, in other examples a different interface may be used. Also, in other examples, the positioning system may be wholly or partially located within the portable microphone 110 and/or within the apparatus 400.

[0062] The position system 450 provides an update of the position of the portable microphone 110 with a particular frequency and the term 'accurate' and 'inaccurate' positioning of the sound object should be understood to mean accurate or inaccurate within the constraints imposed by the frequency of the positional update. That is accurate and inaccurate are relative terms rather than absolute terms.

[0063] The apparatus 400 wholly or partially operates the system 100 and method 200 described above to produce a multi-microphone multichannel audio signal 103.

[0064] The apparatus 400 provides the multi-microphone multichannel audio signal 103 via an output communications interface 404 to an audio output device 300 for rendering.

[0065] In some but not necessarily all examples, the audio output device 300 may use binaural coding. Alternatively or additionally, in some but not necessarily all examples, the audio output device 300 may be a head-mounted audio output device.

[0066] In this example, the apparatus 400 comprises a controller 410 configured to process the signals provided by the static microphone 120 and the portable microphone 110 and the positioning system 450. In some examples, the controller 410 may be required to perform analogue to digital conversion of signals received from microphones 110, 120 and/or perform digital to analogue conversion of signals to the audio output device 300 depending upon the functionality at the microphones 110, 120 and audio output device 300. However, for clarity of presentation no converters are illustrated in Fig. 7.

[0067] Implementation of a controller 410 may be as controller circuitry. The controller 410 may be implemented in hardware alone, have certain aspects in software including firmware alone or can be a combination of hardware and software (including firmware).

[0068] As illustrated in Fig. 7 the controller 410 may be implemented using instructions that enable hardware functionality, for example, by using executable instructions of a computer program 416 in a general-purpose or special-purpose processor 412 that may be stored on a computer readable storage medium (disk, memory etc) to be executed by such a processor 412.

[0069] The processor 412 is configured to read from and write to the memory 414. The processor 412 may also comprise an output interface via which data and/or commands are output by the processor 412 and an input interface via which data and/or commands are input to the processor 412.

[0070] The memory 414 stores a computer program 416 comprising computer program instructions (computer program code) that controls the operation of the apparatus 400 when loaded into the processor 412. The computer program instructions, of the computer program 416, provide the logic and routines that enables the apparatus to perform the methods illustrated in Figs. 1-12. The processor 412 by reading the memory 414 is able to load and execute the computer program 416.

[0071] As illustrated in Fig. 7, the computer program 416 may arrive at the apparatus 400 via any suitable delivery mechanism 430. The delivery mechanism 430 may be, for example, a non-transitory computer-readable storage medium, a computer program product, a memory device, a record medium such as a compact disc read-only memory (CD-ROM) or digital versatile disc (DVD), an article of manufacture that tangibly embodies the computer program 416. The delivery mechanism may be a signal configured to reliably transfer the computer program 416. The apparatus 400 may propagate or transmit the computer program 416 as a computer data signal.

[0072] Although the memory 414 is illustrated as a single component/circuitry it may be implemented as one or more separate components/circuitry some or all of which may be integrated/removable and/or may provide permanent/semi-permanent/ dynamic/cached storage.

[0073] Although the processor 412 is illustrated as a single component/circuitry it may be implemented as one or more separate components/circuitry some or all of which may be integrated/removable. The processor 412 may be a single core or multi-core processor.

[0074] The position system 450 enables a position of the portable microphone 110 to be determined. The position system 450 may receive positioning signals and determine a position which is provided to the processor 412 or it may provide positioning signals or data dependent upon positioning signals so that the processor 412 may determine the position of the portable microphone 110.

[0075] There are many different technologies that may be used by a position system 450 to position an object including passive systems where the positioned object is passive and does not produce a positioning signal and active systems where the positioned object produces one or more positioning signals. An example of system, used in the Kinect ™ device, is when an object is painted with a non-homogenous pattern of symbols using infrared light and the reflected light is measured using multiple cameras and then processed, using the parallax effect, to determine a position of the object. An example of an active radio positioning system is when an object has a transmitter that transmits a radio positioning signal to multiple receivers to enable the object to be positioned by, for example, trilateration or triangulation. An example of a passive radio positioning system is when an object has a receiver or receivers that receive a radio positioning signal from multiple transmitters to enable the object to be positioned by, for example, trilateration or triangulation. Trilateration requires an estimation of a distance of the object from multiple, non-aligned, transmitter/receiver locations at known positions. A distance may, for example, be estimated using time of flight or signal attenuation. Triangulation requires an estimation of a bearing of the object from multiple, non-aligned, transmitter/receiver locations at known positions. A bearing may, for example, be estimated using a transmitter that transmits with a variable narrow aperture, a receiver that receives with a variable narrow aperture, or by detecting phase differences at a diversity receiver.

[0076] Other positioning systems may use dead reckoning and inertial movement or magnetic positioning.

[0077] The object that is positioned may be the portable microphone 110 or it may an object worn or carried by a person associated with the portable microphone 110 or it may be the person associated with the portable microphone 110.

[0078] A problem can arise is relation to positioning using transmission and/or reception of radio signals, particularly indoors, because of multi-path effects arising from reflections. While the high accuracy indoor positioning system (HAIP) is a radio positioning system that addresses such problems, problems can still arise in consistently and accurately positioning a portable microphone 110.

[0079] It is possible for one or more positioning signals received or transmitted by the position system 450 to be subject to noise, resulting in an incorrect position of a portable microphone 110 (incorrect **y** and incorrect z). In a rendered sound scene, this would result in an incorrect positioning of the rendered sound object associated with the portable microphone 110 which can be disconcerting to a listener.

[0080] In some circumstances, for example during the first mode described below, it is possible to correct for noise in the position of the portable microphone 110, for example, because there is enough confidence as when a position of the portable microphone 110 is incorrect.

[0081] In other circumstances, for example during the second mode described below, it is more difficult to correct for noise in the position of the portable microphone 110, for example, because there is not enough confidence as when a position of the portable microphone 110 is incorrect. There may, for example, be confidence that there is an error in one of two positions but there may not be confidence as to which position is erroneous at that time.

[0082] Figs. 8A and 9A both illustrate a plot of how a determined position $p_i(t_i)$ of the portable microphone 110 varies with time t_i. The determined position $p_i(t_i)$ of the portable microphone 110 is the position that is determined or which would be determined based on the original positioning signals by the position system 450. It is the position of the portable microphone 110 based on the measurements made.

[0083] The determined position $p_i(t_i)$ of the portable microphone 110 suffers from noise (deviations from a true position value). There is, in the examples illustrated, frequent low intensity deviation of the determined position $p_i(t_i)$ from a position p_1 Some of the deviation may arise from small variations in the actual position of the portable microphone 110 but some of the deviation may be modeled as an unpredictable small amplitude noise $n_i(t_i)$.

[0084] There may be larger intensity deviations of the determined position $p_i(t_i)$ from the position p_1 In the plots illustrated, there are larger intensity deviations when, for example, $p_i(t_i)= p_2$ and $p_i(t_i)= p_3$. Some of the deviation may arise from variations in the actual position of the portable microphone 110 but some of the deviation may be modeled as an unpredictable error $E_i(t_i)$.

[0085] In a first mode of operation, the signal processing may, for example, use filtering to remove noise from the determined positions $p_i(t_i)$.

[0086] For example a filter may average the determined positions of the portable microphone over a time window, which may be variable. For example, a number N of the immediately preceding determined positions $p_n(t_n)$ for n = i-1, i-2..i-N may be averaged with the determined position $p_i(t_i)$ to provide a processed position $P_i(t_i)$.

This filter may be used to remove the unpredictable small amplitude noise $n_i(t_i)$.

[0087] For example a filter may ignore a change in position because it occurs at greater than a threshold speed. If a change in position is $\Delta p_i = |p_i(t_i) - p_{i-m}(t_{i-m})|$ which occurs over a time interval $\Delta t_i = t_i - t_{i-m,}$ then the speed v_i is given by $\Delta p_i / \Delta t_i$. For example, m may equal 1, and if $v_i > T_i$ then $p_i(t_i) = p_i(t_{i-1})$ else $p_i(t_i) = p_i(t_i)$. The threshold T_i may be variable. This filter may be used to remove the unpredictable errors $E_i(t_i)$.

[0088] For example a filter may ignore a change in position because it occurs at greater than a threshold distance. If a change in position is $\Delta p_i = |p_i(t_i) - p_{i-1}(t_{i-1})|$ exceeds a threshold X_i then $p_i(t_i) = p_i(t_{i-1})$ else $p_i(t_i) = p_i(t_i)$. The threshold X_i may be variable. This filter may be used to remove the unpredictable errors $E_i(t_i)$.

[0089] In a rendered sound scene, this would result in a correct positioning of the rendered sound object associated with the portable microphone 110 despite inaccurate determined positions $p_i(t_i)$.

[0090] Figs. 9A and 9B will be used to explain a second mode of operation of the system 100. In the second mode, some of the deviation (noise) illustrated in Fig. 8A is modeled using a second model as arising from variations in the actual position of the portable microphone 110, some of the deviation is modeled as arising from unpredictable small amplitude noise $n_i(t_i)$.

[0091] However, whereas the first model models all or most large intensity deviations as unpredictable errors $E_i(t_i)$ that do not change the processed position, the second model does not and large intensity deviations in the determined position are more likely to cause a large intensity deviation of the processed position.

[0092] The system 100, in the second mode, may use this second model to attempt to remove the deviation arising from unpredictable small amplitude noise $n_i(t_i)$ in a manner similar to that described for the first model using a filter. The resultant processed position $P_i(t_i)$ of the portable microphone 110 should according to the second model correspond to the actual position of the portable microphone 110.

[0093] Fig. 9B illustrates a plot of how a processed position $P_i(t_i)$ of the portable microphone 110 varies with time t_i. This processed position $P_i(t_i)$ is used to control rendering of the sound object associated with the portable microphone 110. The processed position $P_i(t_i)$, not the determined position $p_i(t_i)$ is used to provide $\underline{\mathbf{z}}$ used by the positioning block 140 to adjust for movement of the sound object associated with the portable microphone 110 relative to the origin.

[0094] It will be appreciated that a consequence of the processing of the determined position $p_i(t_i)$ to produce the usable processed position $P_i(t_i)$, in the second mode, does not necessarily reduce a variance in the position of the portable microphone 110.

[0095] In the second mode of operation, the signal processing used in the first mode to remove the errors $E_i(t_i)$ is not used on the determined positions $p_i(t_i)$ and, in a rendered sound scene, a change in the processed positions $P_i(t_i)$ positioning the rendered sound object associated with the portable microphone 110 occurs when there is a change in the determined position of the portable microphone 110. In the example of Fig. 9B, a change in the processed positions $P_i(t_i)$ from P_1 to P_2 occurs when the determined position $p_i(t_i)$ of the portable microphone 110 changes from p_1 to p_2. In some example P_1 is the same as or very similar to p_1. In some example P_2 is the same as or very similar to p_2. In the example of Fig. 9B, a change in the processed positions $P_i(t_i)$ from P_1 to P_3 occurs when the determined position $p_i(t_i)$ of the portable microphone 110 changes from p_1 to p_3. In some example P_1 is the same as or very similar to p_1 and/or P_3 is the same as or very similar to p_2.

[0096] Fig. 10, illustrates an example of a method 600 suitable for use during the second mode or on transition from the first mode to the second mode. The method generates a distraction, for example a visual distraction when there is a discontinuous or abrupt change in the processed position $P_i(t)$ of the rendered sound object.

[0097] When there is a discontinuous or abrupt change in the processed position $P_i(t)$ of the rendered sound object there is some likelihood that the change in processed position is erroneous. The generation of a visual distraction, simultaneously with the change in position distracts the listener from the error.

[0098] The method 600 comprises, at block 602, providing a process for detecting a change in position $P_i(t)$ of rendering a sound object from a first position at a first time to a second position, different to the first position, at a second time immediately after the first time. If block 602 detects a change in position $P_i(t)$ of rendering the sound object from a first position at a first time to a second position, different to the first position, at a second time immediately after the first time, then the method moves to block 604.

[0099] The method 600 comprises, at block 604, providing a process for generating a visual distraction at the second time.

[0100] Referring back to Fig. 9B, thus when the processed position $P_i(t)$ changes 502 between $P_1(t)$ and $P_3(t)$ in Fig. 9B, a visual distraction 504 is generated.

[0101] Also when the processed position $P_i(t)$ changes 502 between $P_1(t)$ and $P_2(t)$ in Fig. 9B, a visual distraction 504 is generated.

[0102] In the example illustrated, a visual distraction 504 is generated on each transition between $P_1(t)$ and $P_3(t)$ in a first sense only (away from $P_1(t)$). That is, a visual distraction 504 is generated on each transition from $P_1(t)$ to $P_3(t)$. However, in other examples (not illustrated), a visual distraction 504 is generated on each transition between $P_1(t)$ and $P_3(t)$ in a first sense and a second opposite sense (away from and towards $P_1(t)$). That is, a visual distraction 504 is generated on each transition from $P_1(t)$ to $P_3(t)$ and a visual distraction 504 is generated on each transition to $P_1(t)$ from $P_3(t)$.

[0103] In some examples (illustrated), a visual distraction 504 is generated on every qualifying transition between two processed positions $P_i(t_i)$ in a first sense only and in in some examples (not illustrated), a visual distraction 504 is generated on every qualifying transition between two processed positions $P_i(t_i)$ irrespective of the sense of transition, that is, in the first sense and in the opposite second sense.

[0104] A qualifying transition may be a transition in processed position that satisfies a qualifying criterion or criteria.

[0105] One example of a qualifying condition for classifying a change in processed position as a qualifying transition is that the change in position occurs at greater than a threshold speed. If a change in position is $\Delta P_i = P_i(t_i) - P_{i-m}(t_{i-m})$ which occurs over a time interval $\Delta t_i = t_i - t_{i-m}$, then the speed V_i is given by $\Delta P_i / \Delta t_i$. For example, m may equal 1, and if $V_i > Y_i$ then the transition $P_{i-1}(t_{i-1})$ to $P_i(t_i)$ is a qualifying transition and a distraction, for example a visual distraction, is generated at time t_i. The threshold Y_i may be variable.

[0106] One example of a qualifying condition for classifying a change in processed position as a qualifying transition is that the change in position occurs with a greater than a threshold distance, that is, it is a gross change in position. If a change in position is $\Delta P_i = P_i(t_i) - P_{i-m}(t_{i-m})$ which occurs over a time interval, then the distance D_i is given by $|(\Delta P_i)|$. For example, m may equal 1, and if $D_i > Z_i$ then the transition $P_{i-1}(t_{i-1})$ to $P_i(t_i)$ is a qualifying transition and a distraction, for example a visual distraction, is generated at time t_i. The threshold Z_i may be variable.

[0107] Referring to Fig. 9B, in the second mode, when there is a qualifying transition a visual distraction is generated, whereas, referring to Fig. 8B, in the first mode, visual distractions are not generated. Changes in position in the first mode that would qualify for generation of a visual distraction in the second mode are removed by filtering, whereas in the second mode the changes in position are retained but accompanied by a visual distraction.

[0108] The classification of a change in position as a qualifying transition may identify the change as an anomalous change in a processed position of the portable microphone. That is a change in position that cannot physically occur because, for example, the speed of position change is too great.

[0109] Another example of a qualifying condition for classifying a change in processed position as a qualifying transition is that the change in position occurs to a second position at which there is not stage lighting or some other stage effect. The classification of a change in position as a qualifying transition, in this example, may identify the change as an incorrect change in a processed position of the portable microphone. The generated visual distraction may provide the stage lighting or stage effect at the second position, previously determined to be absent.

[0110] In the second mode, a visual distraction may be generated with each qualifying transition, until the second mode is exited.

[0111] In some examples, the visual distractions generated may be generated in real time within an audio scene of the sound object.

[0112] A visual distraction generated may comprises a stage effect for example a lighting effect, a smoke effect, pyrotechnics and/or moving stage objects.

[0113] A visual distraction generated may comprise a lighting effect. A lighting effect may for example comprise a change in a lighting property or lighting properties.

[0114] A change in a lighting effect may comprise one or more of: changing a position of a spotlight, changing a beam width of a spotlight, adding a spot light, removing a spotlight, changing a color, intensity and/or number of spotlights, and changing a lighting pattern.

[0115] In some examples, a visual distraction generated may be dependent upon a classification of a qualifying transition e.g. as anomalous or incorrect.

[0116] In some examples, a visual distraction generated may be dependent upon a property of a qualifying transition, for example, a size of a change in processed position of the rendered sound object.

[0117] In some examples, a visual distraction generated may be dependent upon a history of previous stage effects and/or visual distractions.

[0118] Figs. 11A, 11B and 11C illustrate one example of a changing stage effect 610, in this example a lighting effect, in accordance with the rendering of a sound object based on the processed position of the portable microphone illustrated in Fig. 9B.

[0119] As illustrated in Fig. 11A, when the processed position P is p_1, a spotlight 612 is trained on the position p_1

[0120] As illustrated in Fig. 11B, when there is a qualifying transition and the processed position P changes from p_1 to p_3, a visual distraction is generated by moving the spotlight 612 so that is no longer trained on p_1 but is trained on p_3, while processed position P is p_3.

[0121] As illustrated in Fig. 11C, when there is a qualifying transition and the processed position P changes from p_1 to p_2, a visual distraction is generated by moving the spotlight 612 so that is no longer trained on p_1 but is trained on p_2, while processed position P is p_2.

[0122] In the examples of Figs. 11A-11C, the spotlight 612 follows the processed position P. The distraction generation corresponds to a gross change in position of the spotlight.

[0123] Figs. 12A, 12B and 12C illustrate an example of a changing stage effect 610, in this example a lighting effect, in accordance with the rendering of a sound object based on the processed position of the portable microphone illustrated in Fig. 9B.

[0124] As illustrated in Fig. 12A, when the processed position P is p_1, a spotlight 612 is trained on the position p_1.

[0125] As illustrated in Fig. 12B, when there is a qualifying transition and the processed position P changes from position p_1 to position p_3, a visual distraction is generated by training an additional spotlight 612' on the position p_3, while processed position P is position p_3.

[0126] As illustrated in Fig. 12C, when there is a qualifying transition and the processed position P changes from position p_1 to position p_2, a visual distraction is generated by training an additional spotlight 612' on position p_2, while processed position P is position p_2.

[0127] In the examples of Figs. 12A-12C, the distraction generation corresponds to a new additional spotlight.

[0128] It may, at this stage, be informative to compare and contrast operation of the system 100 under the first mode and the second mode.

[0129] The modes differ in how large intensity deviations in the determined position of a portable microphone (processed positions of a sound object) are handled.

[0130] In the first mode, a position of the sound object (portable microphone 110) is compensated to prevent rapid changes in a position of the rendered sound object. The first mode rejects gross variances in position of the sound object. This compensation removes the unpredictable error $E_i(t_i)$.

[0131] In the second mode, the unpredictable error $E_i(t_i)$ is not modeled or removed and a position of the sound object (portable microphone 110) is not compensated and there may be a rapid changes in a position of the rendered sound object. The second mode accepts gross variances in position of the sound object.

[0132] The first mode may be suitable when it is possible to discriminate between a correct and incorrect position and to correct the incorrect position. That is it is possible to confidently identify an error and confidently remove the error. There is a high level of confidence as to what is an accurate position.

[0133] The second mode may be suitable when it is not possible to discriminate between a correct and incorrect position and/or it is not possible to correct the incorrect position. That is it is not possible to confidently identify an error and confidently remove the error. There is a low level of confidence as to what is an accurate position. There may, for example, be a high degree of confidence that at least some positions are not possible, anomalous, incorrect and arise from error but a lower degree of confidence as to which positions are not possible, anomalous, incorrect and arise from error, that is it is difficult to discriminate between a correct and incorrect position.

[0134] The transition between the first mode and the second mode may be based on processing the determined positions of the portable microphone.

[0135] When there is a level of confidence at or above a threshold value that it is possible to remove an error, the first mode is used.

[0136] When there is a level of confidence below a threshold value that it is possible to remove an error, the second mode is used.

[0137] The system 100 may therefore automatically transition between the first mode and the second mode.

[0138] Thus as noise levels increase and a level of confidence as to what is an accurate position and what is an inaccurate position decreases, the system changes from the first mode to the second mode and generates visual distractions.

[0139] The description of processing positioning signals described should be understood to also encompass processing of data dependent upon the positioning signals.

[0140] The processing of positioning signals to determine a processed position at which a sound object is rendered may or may not occur, wholly or partially, within the position system 450. The processing of positioning signals to determine a processed position at which a sound object is rendered may or may not occur, wholly or partially, within the processor 412 of the apparatus 400.

[0141] The processing of positioning signals to determine a mode for rendering a sound object may or may not occur, wholly or partially, within the position system 450. The processing of positioning signals to determine a mode for rendering a sound object may or may not occur, wholly or partially, within the processor 412 of the apparatus 400.

[0142] The processing to cause a visual distraction to accompany rendering of a sound object may or may not occur, wholly or partially, within the position system 450. The processing to cause a visual distraction to accompany rendering of a sound object may or may not occur, wholly or partially, within the processor 412 of the apparatus 400.

[0143] The method 600 may, for example, be performed by the system 100, for example, using the controller 410 of the apparatus 400.

[0144] It will be appreciated from the foregoing that the various methods 600 described may be performed by an apparatus 400, for example an electronic apparatus 400.

[0145] The electronic apparatus 400 may in some examples be a part of an audio output device 300 such as a head-mounted audio output device or a module for such an audio output device 300. The electronic apparatus 400 may in some examples additionally or alternatively be a part of a head-mounted apparatus 800 comprising the display 420 that displays images to a user.

[0146] It will be appreciated from the foregoing that the various methods 600 described may be performed by a computer program used by such an apparatus 400.

[0147] For example, an apparatus 400 may comprise:

at least one processor 412; and
at least one memory 414 including computer program code
the at least one memory 414 and the computer program code configured to, with the at least one processor 412, cause the apparatus 400 at least to perform:

> causing or performing, detecting a change in position of rendering a sound object from a first position at a first time to a second position, different to the first position, at a second time im-

mediately after the first time; and
causing, at the second time, generating a visual distraction.

[0148] References to 'computer-readable storage medium', 'computer program product', 'tangibly embodied computer program' etc. or a 'controller', 'computer', 'processor' etc. should be understood to encompass not only computers having different architectures such as single /multi- processor architectures and sequential (Von Neumann)/parallel architectures but also specialized circuits such as field-programmable gate arrays (FPGA), application specific circuits (ASIC), signal processing devices and other processing circuitry. References to computer program, instructions, code etc. should be understood to encompass software for a programmable processor or firmware such as, for example, the programmable content of a hardware device whether instructions for a processor, or configuration settings for a fixed-function device, gate array or programmable logic device etc.

[0149] As used in this application, the term 'circuitry' refers to all of the following:

(a) hardware-only circuit implementations (such as implementations in only analog and/or digital circuitry) and
(b) to combinations of circuits and software (and/or firmware), such as (as applicable): (i) to a combination of processor(s) or (ii) to portions of processor(s)/software (including digital signal processor(s)), software, and memory(ies) that work together to cause an apparatus, such as a mobile phone or server, to perform various functions and
(c) to circuits, such as a microprocessor(s) or a portion of a microprocessor(s), that require software or firmware for operation, even if the software or firmware is not physically present.

This definition of 'circuitry' applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term "circuitry" would also cover an implementation of merely a processor (or multiple processors) or portion of a processor and its (or their) accompanying software and/or firmware. The term "circuitry" would also cover, for example and if applicable to the particular claim element, a baseband integrated circuit or applications processor integrated circuit for a mobile phone or a similar integrated circuit in a server, a cellular network device, or other network device.

[0150] The blocks illustrated in the Figs. 1-12 may represent steps in a method and/or sections of code in the computer program 416. The illustration of a particular order to the blocks does not necessarily imply that there is a required or preferred order for the blocks and the order and arrangement of the block may be varied. Furthermore, it may be possible for some blocks to be omitted.

[0151] Where a structural feature has been described, it may be replaced by means for performing one or more of the functions of the structural feature whether that function or those functions are explicitly or implicitly described.

[0152] As used here 'module' refers to a unit or apparatus that excludes certain parts/components that would be added by an end manufacturer or a user.

[0153] The term 'comprise' is used in this document with an inclusive not an exclusive meaning. That is any reference to X comprising Y indicates that X may comprise only one Y or may comprise more than one Y. If it is intended to use 'comprise' with an exclusive meaning then it will be made clear in the context by referring to "comprising only one..." or by using "consisting".

[0154] In this brief description, reference has been made to various examples. The description of features or functions in relation to an example indicates that those features or functions are present in that example. The use of the term 'example' or 'for example' or 'may' in the text denotes, whether explicitly stated or not, that such features or functions are present in at least the described example, whether described as an example or not, and that they can be, but are not necessarily, present in some of or all other examples. Thus 'example', 'for example' or 'may' refers to a particular instance in a class of examples. A property of the instance can be a property of only that instance or a property of the class or a property of a sub-class of the class that includes some but not all of the instances in the class. It is therefore implicitly disclosed that a feature described with reference to one example but not with reference to another example, can where possible be used in that other example but does not necessarily have to be used in that other example.

[0155] Although embodiments of the present invention have been described in the preceding paragraphs with reference to various examples, it should be appreciated that modifications to the examples given can be made without departing from the scope of the invention as claimed.

[0156] Features described in the preceding description may be used in combinations other than the combinations explicitly described.

[0157] Although functions have been described with reference to certain features, those functions may be performable by other features whether described or not.

[0158] Although features have been described with reference to certain embodiments, those features may also be present in other embodiments whether described or not.

[0159] Whilst endeavoring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

Claims

1. A method comprising:

   detecting a change in position of rendering a sound object from a first position at a first time to a second position, different to the first position, at a second time immediately after the first time; and
   at the second time, generating a visual distraction.

2. A method as claimed in claim 1, comprising:

   detecting an anomalous change in a position of rendering the sound object; and
   in dependence on said detection, generating the visual distraction.

3. A method as claimed in claim 1 or 2, comprising:

   detecting that a position of rendering the sound object is incorrect; and
   in dependence on said detection, generating the visual distraction.

4. A method as claimed in any preceding claim, comprising:

   detecting that a difference between the first position and the second position satisfies a qualifying transition criterion; and
   in dependence on said detection, generating the visual distraction.

5. A method as claimed in any preceding claim, comprising:

   processing one or more positioning signals for positioning the sound object to perform said detection.

6. A method as claimed in any preceding claim, comprising:

   following the second time, entering a mode in which a visual distraction is generated with each gross change in position of the sound object, until the mode is exited.

7. A method as claimed in any preceding claim, comprising:

   following the second time, entering a mode in which a visual distraction is generated with each anomalous change in a position of rendering the sound object detected, until the mode is exited.

8. A method as claimed in claim 6 or claim 7, comprising:

   before entering the mode, compensating a position of the sound object to prevent rapid changes in a position of the rendered sound object, and after entering the mode, not compensating a position of a sound object to enable rapid changes in a position of the rendered sound object.

9. A method as claimed in any preceding claim, comprising, before the first time:

   maintaining a position at which a sound object is rendered despite a gross variation in a position of the sound object.

10. A method as claimed in any preceding claim, comprising, before the first time, removing gross variations in a position of the sound object until a threshold is exceeded at the second time.

11. A method as claimed in any preceding claim wherein the visual distraction is generated in real time within an audio scene of the sound object.

12. A method as claimed in any preceding claim, wherein the visual distraction generated comprises a stage effect and/or a lighting effect, and/or wherein the distraction generated is a change in a lighting property selected from the group comprising positioning of a spotlight, beam width of a spotlight, color, intensity and/or number of spotlights, and lighting pattern.

13. A method as claimed in any preceding claim, wherein the visual distraction is dependent upon a difference between the first position and the second position.

14. A method as claimed in any preceding claim, wherein the sound object is associated with a Lavalier microphone.

15. A computer program that when run on a processor causes performance of the method of any of claims 1 to 14 or a system comprising means for performing the method of any of claims 1 to 14 or an apparatus comprising means for performing the method of any of claims 1 to 14.

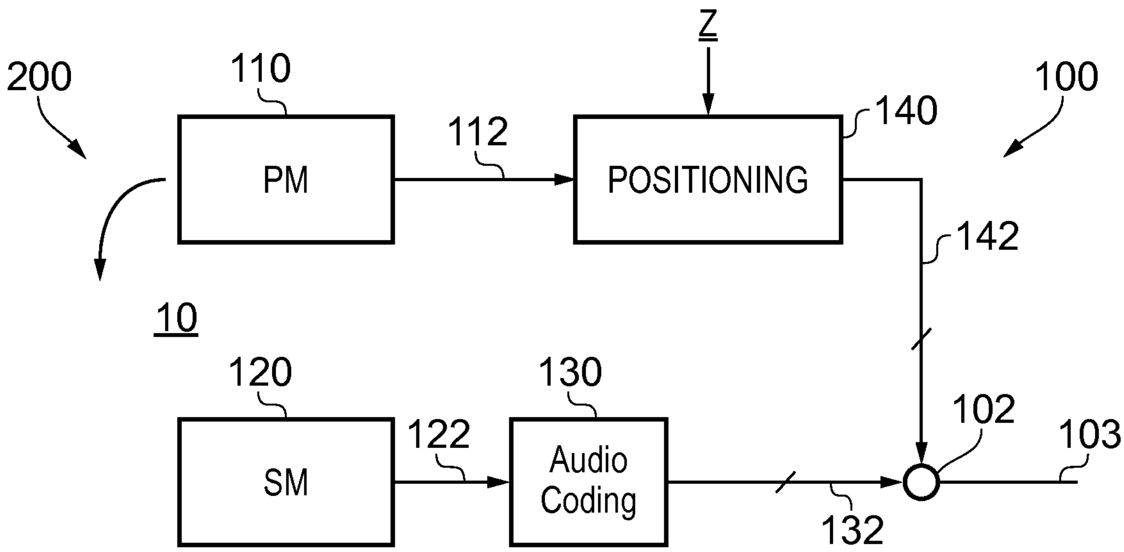


FIG. 1

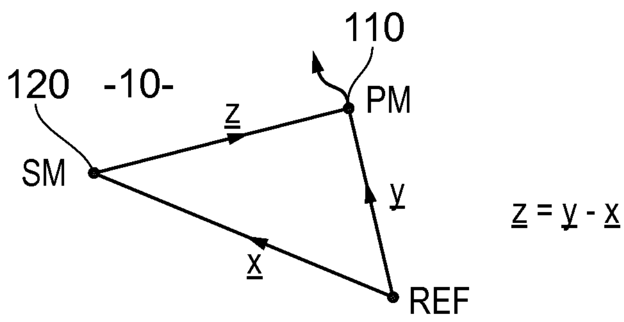


FIG. 2

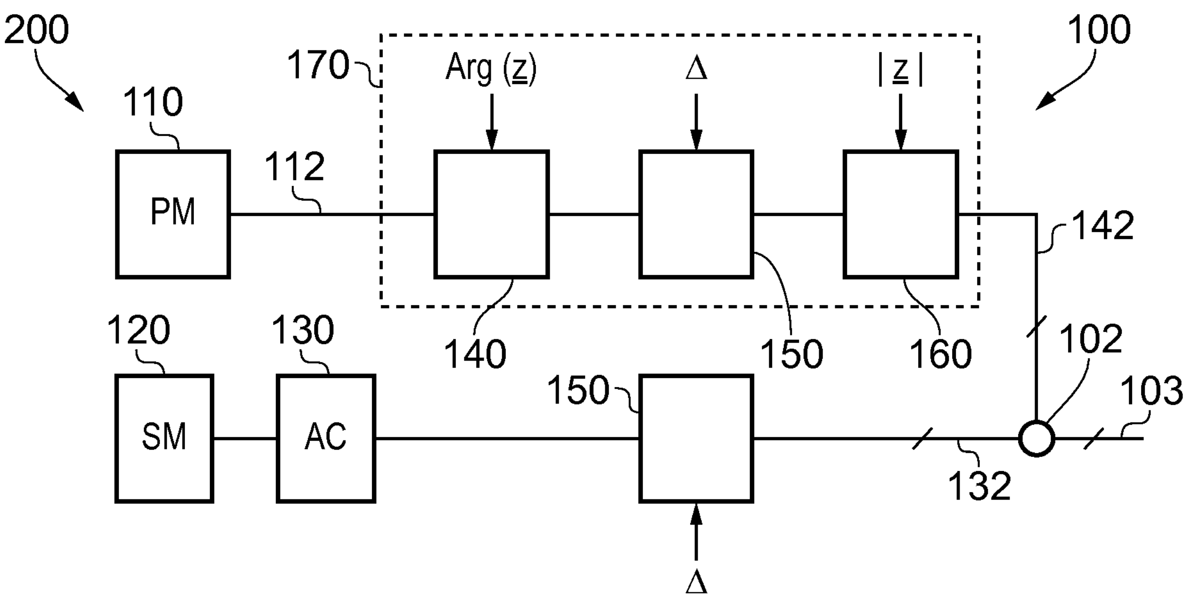


FIG. 3

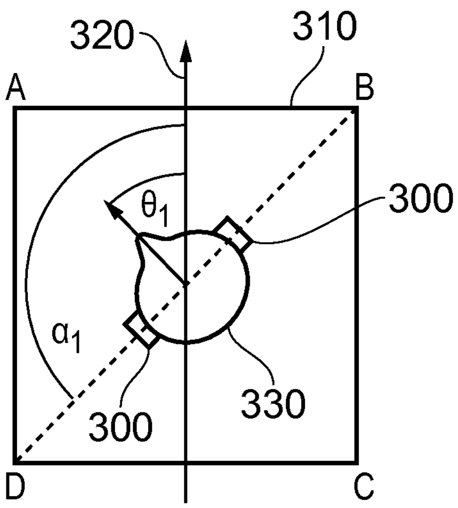
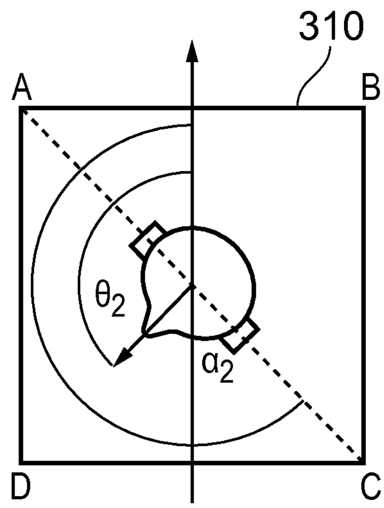


FIG. 4A



$\theta_2 - \theta_1 = \alpha_2 - \alpha_1 = \Delta$

FIG. 4B

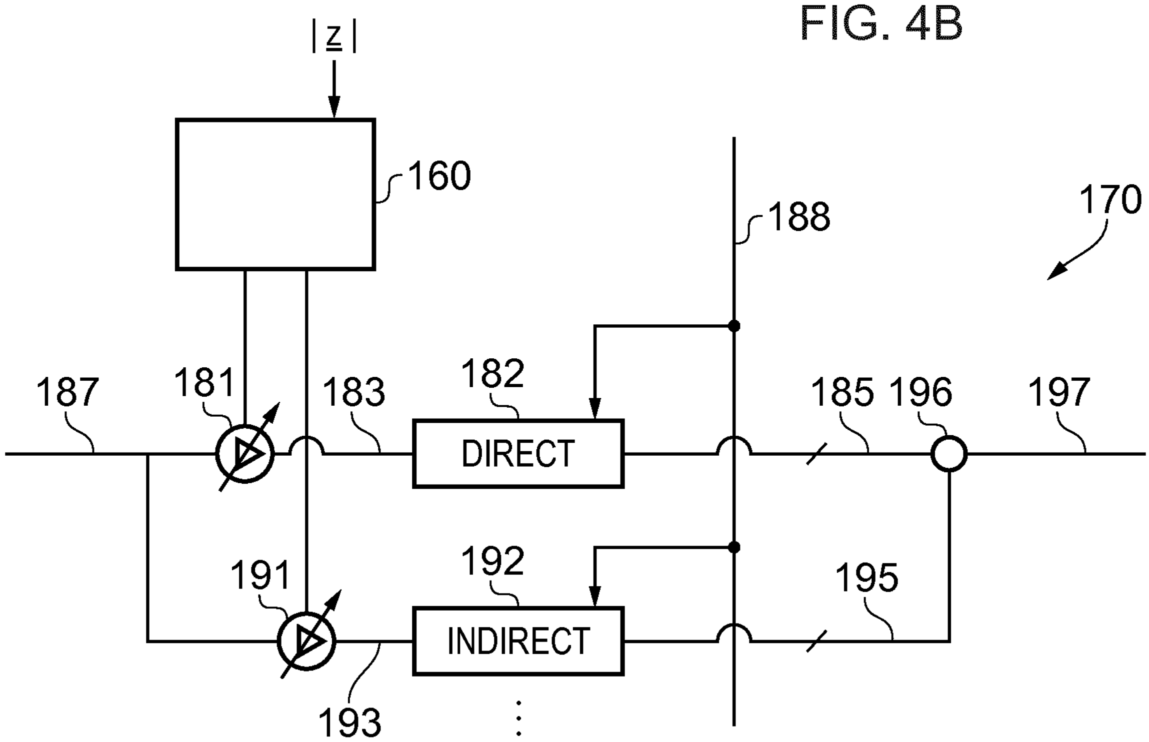


FIG. 5

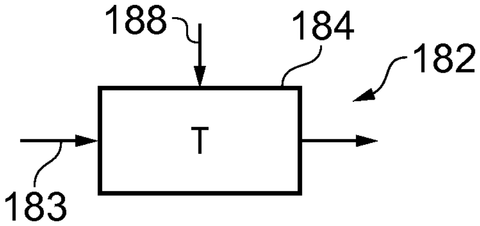


FIG. 6A

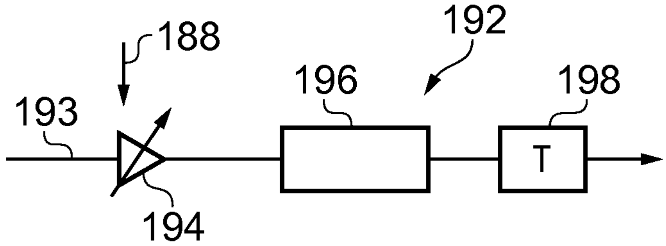


FIG. 6B

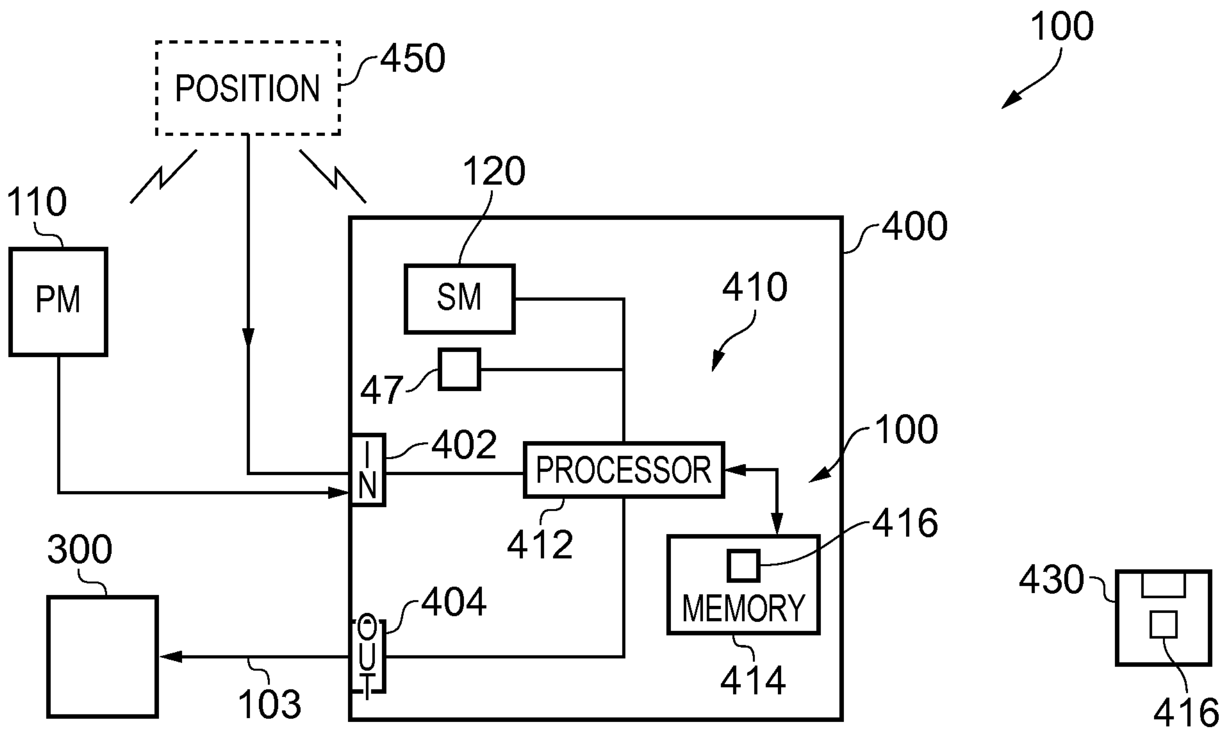

100
POSITION
450
110
120
400
PM
SM
410
47
402
100
PROCESSOR
412
416
300
430
MEMORY
404
OUT
414
103
416

FIG. 7

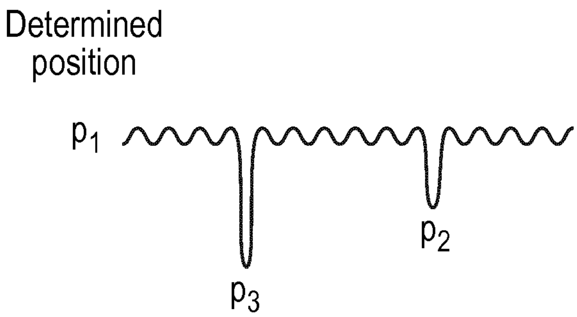


FIG. 8A

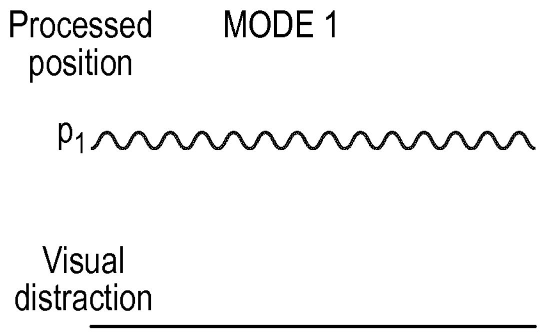


FIG. 8B

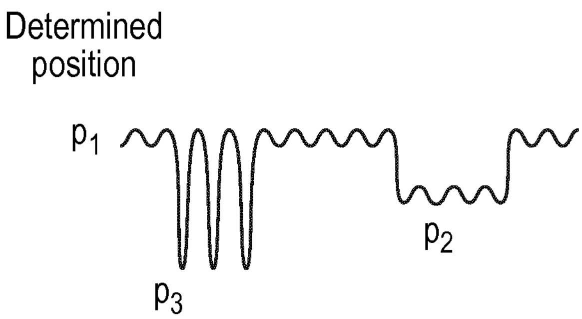


FIG. 9A

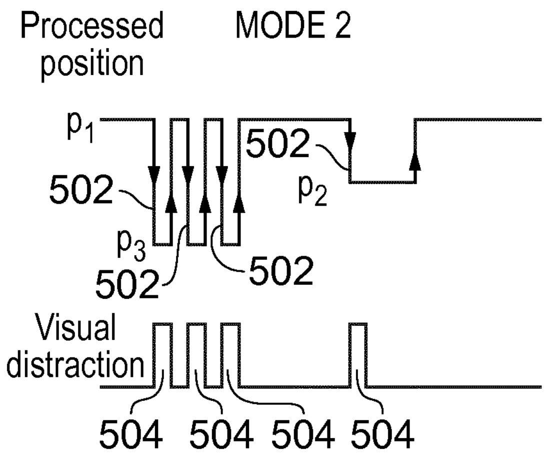


FIG. 9B

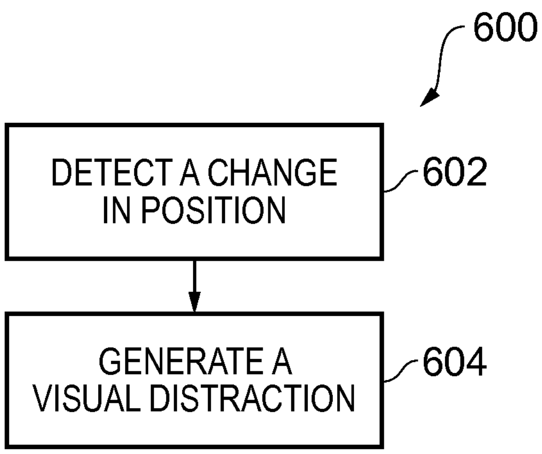


FIG. 10

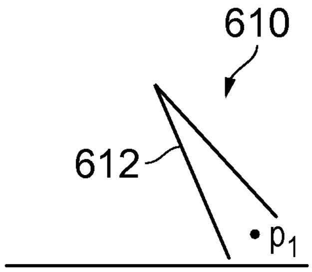


FIG. 11A

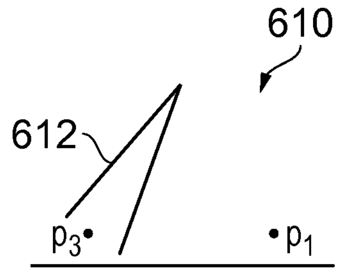


FIG. 11B

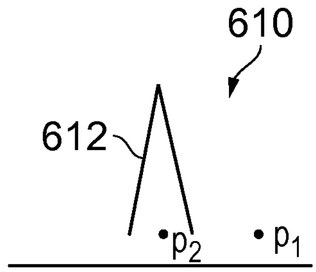


FIG. 11C

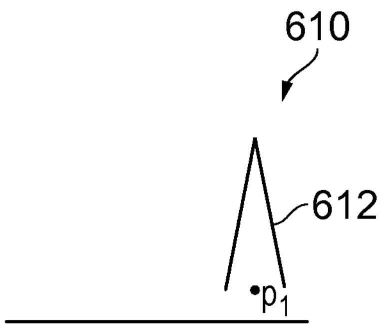


FIG. 12A

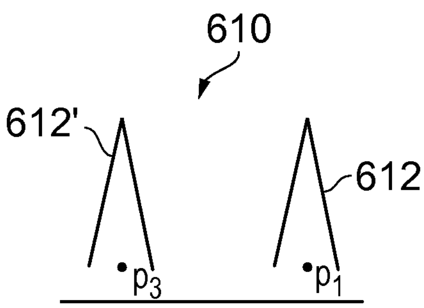


FIG. 12B

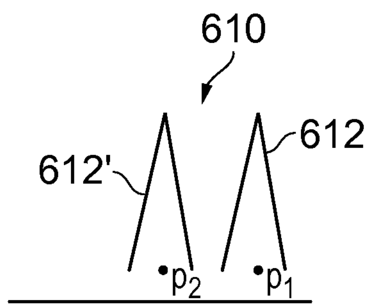


FIG. 12C

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EUROPEAN SEARCH REPORT

Application Number
EP 16 17 1383

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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G10L
H04S
H04R

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	21 November 2016	Mendoza Lopez, Jorge

CATEGORY OF CITED DOCUMENTS

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