

CLAIMS

1. A method of producing an acoustic field from an array of transducers having known relative positions and orientations, the method comprising:

5 -defining a plurality of control points which each have a known spatial relationship relative to the array of transducers;

 - assigning an amplitude to each control point; the method characterised by comprising:

10 - computing a matrix containing elements which represent, for each of the control points, the effect that producing a modeled acoustic field having the assigned amplitude with a particular phase at the control point has on the consequential amplitude and phase of the modeled acoustic field at the other control points;

 - determining eigenvectors of the matrix, each eigenvector representing a set of phases and relative amplitudes of the modeled acoustic field at the control points; and

15 - selecting one of the sets and operating the transducer array to cause one or more of the transducers to output an acoustic wave each having an initial amplitude and phase such that the phases and amplitudes of the resultant acoustic field at the control points correspond to the phases and relative amplitudes of the selected eigenvector set.

20 2. The method of claim 1 further comprising determining eigenvalues of the matrix, the eigenvalues representing scaling factors, some of which will be relatively high and some of which will be relatively low, wherein a set of phases and relative amplitudes with a relatively high corresponding eigenvalue is selected as the selected set.

25 3. The method of any preceding claim wherein the effect of producing the assigned amplitude at one of the control points on the amplitude and phases at each of the other control points is computed using a look-up function which defines how the amplitude and phase of the acoustic waves varies spatially due to attenuation and propagation.

4. The method of any preceding claim including a regularisation step in which errors are introduced into the initial amplitude and phase output by the transducers.

5. The method of any preceding claim wherein the power output by the transducer array is scaled such that the transducer outputting the highest of the initial amplitudes operates at substantially full power.

6. The method of any preceding claim, wherein the acoustic waves are ultrasound waves and/or the acoustic waves are modulated at a frequency between 0.1Hz to 500Hz

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7. The method of any preceding claim, wherein the control points comprise a first group of control points at which the acoustic field has a relatively high amplitude and a second group of control points at which the acoustic field has a relatively low amplitude relative to the amplitude of the acoustic field at the first group of control points, the control points in the second group being adjacent to the first group of control points such that a gradient in amplitude of the acoustic field is produced.

8. The method of any preceding claim, wherein the positions of at least some of the control points are chosen to define parts of a virtual three-dimensional shape within a volume within which the acoustic field may exist.

9. The method of claim 8, wherein the control points are positioned in the region of points where an object intersects the virtual shape.

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10. An apparatus (26) for producing an acoustic field, the apparatus comprising an array of transducers (68) having known relative positions and orientations, and a data processor (64), characterised in that the data processor is configured to:

-compute a matrix containing elements which represent for each of a plurality of control points, which each have a known spatial relationship relative to the array of

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transducers and each have an amplitude assigned to them, the effect that producing a modeled acoustic field having the assigned amplitude with a particular phase at the control point has on the consequential amplitude and phase of the modeled acoustic field at the other control points;

5 - determine eigenvectors of the matrix, each eigenvector representing a set of phases and relative amplitudes of the modeled acoustic field at the control points;

 - cause one or more of the transducers to output an acoustic wave each having an initial amplitude and phase such that the phases and amplitudes of the resultant acoustic field at the control points correspond to the phases and relative amplitudes of a selected
10 eigenvector set.

11. An apparatus according to claim 10, additionally arranged to determine eigenvalues of the matrix, the eigenvalues representing scaling factors, some of which will be relatively high and some of which will be relatively low, wherein a set of phases and
15 relative amplitudes with a relatively high corresponding eigenvalue is selected as the selected set.

12. An apparatus according to claims 10 or 11, the data processor being additionally arranged to perform a regularisation step in which errors are introduced into the initial
20 amplitude and phase output by the transducers.

13. An apparatus according to any of claims 10 to 12 wherein the apparatus is arranged to modulate the acoustic waves at a frequency between 0.1Hz to 500Hz.

25 14. An apparatus according to any of claims 10 to 13, further comprising an object tracker, configured to choose positions of the control points based on the data captured by the object tracker.

15. A data processor configured to perform the method of claim 1.