CLAIMS

1. A method for determines coefficients in a representation of coil sensitivities and MR information associated with a sample, comprising:

by a computer:

acquiring, from a measurement device or memory, magnetic resonance (MR) signals associated with a sample;

accessing a predetermined set of coil magnetic field basis vectors, wherein coil sensitivities of coils in the measurement device are represented by weighted superpositions of the predetermined set of coil magnetic field basis vectors using the coefficients, and wherein the predetermined coil magnetic field basis vectors are solutions to Maxwell's equations in a field of view of an MR apparatus; and

solving a nonlinear optimization problem for the MR information associated with the sample and the coefficients using the MR signals, a forward model that provides predicted MR responses based at least in part on forward-model parameters and at a given external magnetic field strength, and the predetermined set of coil magnetic field basis vectors.

2. The method of claim 1, wherein a given coil sensitivity is represented by a linear superposition of products of the coefficients and predetermined coil magnetic field basis vectors in the predetermined set of coil magnetic field basis vectors.

3. The method of claim 1, wherein the nonlinear optimization problem comprises a term corresponding to a squared absolute value of a difference between the MR signals and estimated MR signals that correspond to the MR information; and

wherein the term comprises a contribution from the coil sensitivities of the coils in the measurement device.

4. The method of claim 3, wherein the nonlinear optimization problem comprises one or more constraints on a reduction or minimization of the term; and

wherein the one or more constraints comprise a regularizer corresponding to a spatial distribution of the MR information.

5. The method of claim 1, wherein the MR information comprises an image with a spatial distribution of one or more MR parameters in voxels associated with the sample,

which are specified by the MR signals.

6. The method of claim 1, wherein the MR signals correspond to magnetic resonance imaging (MRI) or another MR measurement technique.

7. The method of claim 1, wherein the MR information comprises quantitative values of one or more MR parameters in voxels associated with the sample, which are specified by the MR signals.

8. The method of claim 1, wherein the measurement device performs tensor field mapping, MR fingerprinting or another quantitative MR measurement technique.

9. The method of claim 1, wherein the nonlinear optimization problem is solved iteratively until a convergence criterion is achieved.

10. The method of claim 1, wherein the nonlinear optimization problem is solved using a pretrained neural network or a pretrained machine-learning model that maps the MR signals and the set of coil magnetic field basis vectors to the MR information and the coefficients.

11. The method of claim 1, wherein solving the nonlinear optimization problem reconstructs MR scan lines that were skipped during measurements performed by the measurement device.

12. The method of claim 1, wherein an MR scan time of measurements performed by the measurement device is reduced relative to a magnetic resonance imaging (MRI) parallel imaging technique.

13. A computer, comprising:

an interface circuit configured to communicate with a measurement device;

memory configured to store program instructions; and

a processor configured to executes the program instructions, wherein, when executed by the processor, the program instructions cause the computer to perform operations comprising:

acquiring, from the measurement device or the memory, magnetic resonance (MR) signals associated with a sample;

accessing a predetermined set of coil magnetic field basis vectors, wherein coil sensitivities of coils in the measurement device are represented by weighted superpositions of the predetermined set of coil magnetic field basis vectors using

coefficients, and wherein the predetermined coil magnetic field basis vectors are solutions to Maxwell's equations in a field of view of an MR apparatus; and

solving a nonlinear optimization problem for MR information associated with the sample and the coefficients using the MR signals, a forward model that provides predicted MR responses based at least in part on forward-model parameters and at a given external magnetic field strength, and the predetermined set of coil magnetic field basis vectors.

14. The computer of claim 13, wherein the nonlinear optimization problem comprises a term corresponding to a squared absolute value of a difference between the MR signals and estimated MR signals that correspond to the MR information; and

wherein the term comprises a contribution from the coil sensitivities of the coils in the measurement device.

15. The computer of claim 13, wherein the MR information comprises an image with a spatial distribution of one or more MR parameters in voxels associated with the sample, which are specified by the MR signals.

16. The computer of claim 13, wherein the MR signals correspond to magnetic resonance imaging (MRI) or another MR measurement technique.

17. The computer of claim 13, wherein the MR information comprises quantitative values of one or more MR parameters in voxels associated with the sample, which are specified by the MR signals.

18. The computer of claim 13, wherein the MR signals correspond to tensor field mapping, MR fingerprinting or another quantitative MR measurement technique.

19. The computer of claim 13, wherein the nonlinear optimization problem is solved iteratively until a convergence criterion is achieved.

20. The computer of claim 13, wherein the nonlinear optimization problem is solved using a pretrained neural network or a pretrained machine-learning model that maps the MR signals and the set of coil magnetic field basis vectors to the MR information and the coefficients.

21. The computer of claim 13, wherein solving the nonlinear optimization problem reconstructs MR scan lines that were skipped during measurements performed by the

measurement device.

22. The computer of claim 13, wherein an MR scan time of measurements performed by the measurement device is reduced relative to a magnetic resonance imaging (MRI) parallel imaging technique.

23. A non-transitory computer-readable storage medium for use in conjunction with a computer, the computer-readable storage medium configured to store program instructions that, when executed by the computer, cause the computer to perform operations comprising:

acquiring, from a measurement device or memory, magnetic resonance (MR) signals associated with a sample;

accessing a predetermined set of coil magnetic field basis vectors, wherein coil sensitivities of coils in the measurement device are represented by weighted superpositions of the predetermined set of coil magnetic field basis vectors using coefficients, and wherein the predetermined coil magnetic field basis vectors are solutions to Maxwell's equations in a field of view of an MR apparatus; and

solving a nonlinear optimization problem for MR information associated with the sample and the coefficients using the MR signals, a forward model that provides predicted MR responses based at least in part on forward-model parameters and at a given external magnetic field strength, and the predetermined set of coil magnetic field basis vectors.

24. The non-transitory computer-readable storage medium of claim 23, wherein the nonlinear optimization problem comprises a term corresponding to a squared absolute value of a difference between the MR signals and estimated MR signals that correspond to the MR information; and

wherein the term comprises a contribution from the coil sensitivities of the coils in the measurement device.

25. The non-transitory computer-readable storage medium of claim 23, wherein the MR information comprises an image with a spatial distribution of one or more MR parameters in voxels associated with the sample, which are specified by the MR signals.

26. The non-transitory computer-readable storage medium of claim 23, wherein the MR signals correspond to magnetic resonance imaging (MRI) or another MR measurement technique.

27. The non-transitory computer-readable storage medium of claim 23, wherein the MR information comprises quantitative values of one or more MR parameters in voxels associated with the sample, which are specified by the MR signals.

28. The non-transitory computer-readable storage medium of claim 23, wherein the MR signals correspond to tensor field mapping, MR fingerprinting or another quantitative MR measurement technique.

29. The non-transitory computer-readable storage medium of claim 23, wherein the nonlinear optimization problem is solved iteratively until a convergence criterion is achieved.

30. The non-transitory computer-readable storage medium of claim 23, wherein the nonlinear optimization problem is solved using a pretrained neural network or a pretrained machine-learning model that maps the MR signals and the set of coil magnetic field basis vectors to the MR information and the coefficients.

31. The non-transitory computer-readable storage medium of claim 23, wherein solving the nonlinear optimization problem reconstructs MR scan lines that were skipped during measurements performed by the measurement device.

32. The non-transitory computer-readable storage medium of claim 23, wherein an MR scan time of measurements performed by the measurement device is reduced relative to a magnetic resonance imaging (MRI) parallel imaging technique.