CLAIMS

What is claimed is:

1. A system comprising:

a robotic system having a maximum number of degrees of freedom associated therewith, wherein the maximum number of degrees of freedom corresponds to a maximum number of modes in which the robotic system can move;

a graphical user interface configured to receive a natural robot task having at least one natural workpiece constraint associated with the natural robot task, wherein the natural robot task includes a task that is performed using a reduced amount of motion;

a scanner configured to automatically scan an entire workpiece; and

a processor configured to identify a minimum number of degrees of freedom required to perform the natural robot task, wherein the minimum number of degrees of freedom is based upon, at least in part, the scanned workpiece and the at least one natural workpiece constraint associated with the natural robot task, wherein the minimum number of degrees of freedom is a minimum number of modes in which the robotic system can move to perform the natural robot task, wherein the processor determines how to perform the natural robot task automatically.

2. The system of claim 1, wherein the at least one natural workpiece constraint associated with the natural robot task is selected from a group consisting of directional constraints, assignment to a curve or surface, distance constraints, joint positions, linear and nonlinear functional combinations of joint positions, workpiece geometry, workpiece features, center of mass, and linear and angular momentum.

3. The system of claim 1, further comprising:

a scanner configured to identify the at least one natural workpiece constraint associated with the natural robot task.

4. The system of claim 3, wherein the at least one natural workpiece constraint associated with the natural robot task or the identification of a minimum number of degrees of freedom is determined automatically, in response to the scanner identification.

5. The system of claim 1, further comprising:

a simulator configured to determine a feasible or an optimized implementation of the natural robot task.

6. The system of claim 1, wherein receiving the natural robot task is received in conjunction with a learning demonstration.

7. The system of claim 1, wherein the minimum number of degrees of freedom is less than the maximum number of degrees of freedom.

8. The system of claim 1, wherein the at least one natural workpiece constraint associated with the natural robot task or the identification of a minimum number of degrees of freedom is specified by a user.

9. The system of claim 1, wherein the at least one natural workpiece constraint associated with the natural robot task or the identification of a minimum number of degrees of freedom is updated in real-time during an operation of the robotic system.

10. The system of claim 1, wherein the minimum number of degrees of freedom is based upon, at least in part, sensor data.

11. The system of claim 1, wherein the at least one natural workpiece constraint associated with the natural robot task or the identification of a minimum number of degrees of freedom is updated using a communication channel before, during, or after an operation of the robotic system.

12. The system of claim 1, wherein the graphical user interface is at least one of a two-dimensional interface or a three-dimensional interface.

13. The system of claim 1, wherein the natural robot task is received by the system without referencing a robotic system frame used to control the robotic system.

14. The system of claim 1, wherein the minimum number of degrees of freedom is identified

by referencing only one or more features and a geometry of a workpiece.

15. The system of claim 1, wherein the processor is configured to control the robotic system to perform the natural robot task by exploring an extra degree of freedom, wherein the extra degree of freedom is based upon, at least in part, a different between the maximum number of degrees of freedom and the minimum number of degrees of freedom.

16. The system of claim 15, wherein exploring the extra degree of freedom includes optimizing a criteria using the extra degrees of freedom to solve a gradient-based problem that seeks to minimize the criteria.

17. The system of claim 1, wherein the processor and scanner are configured to define a workspace prior to performing a robotic task.

18. The system of claim 17, wherein the at least one natural environmental constraint includes a peg-in-hole insertion, line following, camera pointing, grasping a symmetrical object, placing an object on a flat surface, contacting a flat object with a suction cup, steering a mobile base, or controlling the center of mass of a mobile robot to product stability.

19. The system of claim 1, wherein the natural robot task includes at least one natural environmental constraint associated with the natural robot task.

20. The system of claim 1, wherein the at least one natural workpiece constraint includes one or more geometrical features associated with a particular workpiece.

21. The system of claim 1, wherein the processor is configured to control the robotic system to perform the natural robot task by exploring relaxing a degree of freedom.

22. A robotic method comprising:

providing a robotic system having a maximum number of degrees of freedom associated therewith, wherein the maximum number of degrees of freedom corresponds to a maximum number of modes in which the robotic system can move;

receiving, at a graphical user interface, a natural robot task having at least one natural workpiece constraint associated with the natural robot task, wherein the natural robot task includes a task that is performed using a reduced amount of motion; and

automatically scanning an entire workpiece; and

identifying, using at least one processor, a minimum number of degrees of freedom required to perform the natural robot task, wherein the minimum number of degrees of freedom is based upon, at least in part, the scanned workpiece and the at least one natural workpiece constraint associated with the natural robot task, wherein the minimum number of degrees of freedom is a minimum number of modes in which the robotic system can move to perform the natural robot task, wherein the processor determines how to perform the natural robot task automatically.

23. The robotic method of claim 22, wherein the at least one natural workpiece constraint associated with the natural robot task is selected from a group consisting of directional constraints, assignment to a curve or surface, distance constraints, joint positions, linear and nonlinear functional combinations of joint positions, workpiece geometry, workpiece features, center of mass, and linear and angular momentum.

24. The robotic method of claim 22, further comprising:

identifying, based upon, at least in part, a scanner, the at least one natural workpiece constraint associated with the natural robot task.

25. The robotic method of claim 24, wherein the at least one natural workpiece constraint associated with the natural robot task or the identification of a minimum number of degrees of freedom is determined automatically, in response to the scanner identification.

26. The robotic method of claim 22, further comprising:

determining, based upon, at least in part, a simulation, a feasible or an optimized implementation of the natural robot task.

27. The robotic method of claim 22, wherein receiving the natural robot task is received in conjunction with a learning demonstration.

28. The robotic method of claim 22, wherein the minimum number of degrees of freedom is less than the maximum number of degrees of freedom.

29. The robotic method of claim 22, wherein the at least one natural workpiece constraint associated with the natural robot task or the identification of a minimum number of degrees of freedom is specified by a user.

30. The robotic method of claim 22, wherein the at least one natural workpiece constraint associated with the natural robot task or the identification of a minimum number of degrees of freedom is updated in real-time during an operation of the robotic system.

31. The robotic method of claim 22, wherein the minimum number of degrees of freedom is based upon, at least in part, sensor data.

32. The robotic method of claim 22, wherein the at least one natural workpiece constraint associated with the natural robot task or the identification of a minimum number of degrees of freedom is updated using a communication channel before, during, or after an operation of the robotic system.

33. The robotic method of claim 22, wherein the graphical user interface is at least one of a two-dimensional interface or a three-dimensional interface.

34. The robotic method of claim 22, wherein the minimum number of degrees of freedom is identified without referencing a robotic method frame used to control the robotic system.

35. The robotic method of claim 22, wherein the minimum number of degrees of freedom is identified by referencing only one or more features and a geometry of a workpiece.

36. The robotic method of claim 22, further comprising:

controlling, using the at least one processor, the robotic system to perform the natural robot task by exploring an extra degree of freedom, wherein the extra degree of freedom is based upon, at least in part, a difference between the maximum number of degrees of freedom and the minimum number of degrees of freedom.

37. The robotic method of claim 22, further comprising:

defining a workspace prior to performing a robotic task wherein defining is based upon, at least in part, data from the processor and the scanner.

38. The robotic method of claim 22, wherein the natural robot task includes at least one natural environmental constraint associated with the natural robot task.

39. The robotic method of claim 38, wherein the at least one natural environmental constraint includes a peg-in-hole insertion, line following, camera pointing, grasping a symmetrical object, placing an object on a flat surface, contacting a flat object with a suction cup, steering a mobile base, or controlling the center of mass of a mobile robot to product stability.

40. The robotic method of claim 22, wherein the at least one natural workpiece constraint includes geometrical features associated with a particular workpiece.

41. The robotic method of claim 22, wherein the at least one natural workpiece constraints is of the less-than-or-equal-to type rather than the equal-to type.

42. The robotic method of claim 22, wherein a manipulator Jacobian is used, at least in part, to calculate motion associated with the robotic system.