CLAIMS

1. A method of operation of a robot to grasp an object, wherein the robot includes:

a robotic hand having multiple fingers and an opposable thumb;

at least one processor operative to control actuations of the robotic hand;

at least one sensor communicatively coupled to the at least one processor; and

a non-transitory processor-readable storage medium communicatively coupled to the at least one processor, the non-transitory processor-readable storage medium storing a library of reusable grasp primitives and processor-executable instructions that, when executed by the at least one processor, cause the robotic hand to autonomously perform the reusable grasp primitives in the library of reusable grasp primitives, the method comprising:

collecting data about the object by the at least one sensor;

analyzing the data by the at least one processor to determine a geometry of the object;

selecting, by the at least one processor, a particular reusable grasp primitive from the library of reusable grasp primitives based, at least in part, on the geometry of the object; and

executing, by the robotic hand, the particular reusable grasp primitive to grasp the object.

2. The method of claim 1 wherein executing, by the robotic hand, the particular reusable grasp primitive to grasp the object includes executing, by the at least one processor, processor-executable instructions that cause the robotic hand to autonomously perform the particular reusable grasp primitive to grasp the object.

3. The method of claim 1 wherein the at least one sensor includes at least one optical sensor, and wherein:

collecting data about the object by the at least one sensor includes collecting optical data about the object by the at least one optical sensor; and

analyzing the data by the at least one processor to determine a geometry of the object includes analyzing the optical data by the at least one processor to determine the geometry of the object.

4. The method of claim 1 wherein selecting, by the at least one processor, a particular reusable grasp primitive from the library of reusable grasp primitives based, at least in part, on the geometry of the object includes selecting, by the at least one processor, the particular reusable grasp primitive that best fits the geometry of the object relative to all other reusable grasp primitives in the library of reusable grasp primitives.

5. The method of claim 4 wherein selecting, by the at least one processor, the particular reusable grasp primitive that best fits the geometry of the object includes selecting, by the at least one processor, the particular reusable grasp primitive that employs a configuration of the multiple fingers and the opposable thumb of the robotic hand that best accommodates the geometry of the object relative to all other reusable grasp primitives in the library of reusable grasp primitives.

6. The method of claim 1 wherein selecting, by the at least one processor, the particular reusable grasp primitive that best fits the geometry of the object includes simulating, by the at least one processor, the robotic hand grasping the object with each reusable grasp primitive in the library of reusable grasp primitives to determine which particular reusable grasp primitive in the library of reusable grasp primitives best fits the geometry of the object relative to all other grasp primitives in the library of reusable grasp primitives.

7. The method of claim 1, further comprising:

analyzing additional data about the object by the at least one processor to determine at least one additional parameter of the object, wherein selecting, by the at least one processor, a particular reusable grasp primitive from the library of reusable grasp primitives based, at least in part, on the geometry of the object includes selecting, by the at least one processor, the particular reusable grasp primitive from the library of reusable grasp primitives based, at least in part, on both the geometry of the object and the at least one additional parameter of the object.

8. The method of claim 7, further comprising:

collecting the additional data about the object by the at least one sensor, and wherein the additional data about the object is selected from a group consisting of: a

hardness of the object, a rigidity of the object, an identity of the object, a function of the object, and a mass of the object.

9. The method of claim 7 wherein the robot further includes at least one receiver communicatively coupled to the at least one processor, and wherein the method further comprises:

receiving the additional data about the object by the receiver.

10. The method of claim 1 wherein the non-transitory processor-readable storage medium further stores data about a work objective to be performed by the robot, the work objective involving grasping the object, and wherein selecting, by the at least one processor, a particular reusable grasp primitive from the library of reusable grasp primitives based, at least in part, on the geometry of the object includes selecting, by the at least one processor, the particular reusable grasp primitive from the library of reusable grasp primitives based, at least in part, on both the geometry of the object and the data about the work objective to be performed by the robot.

11. A robot comprising:

a body;

a robotic hand mechanically coupled to the body, the robotic hand having multiple fingers and an opposable thumb;

at least one processor operative to control actuations of the robotic hand;

at least one sensor communicatively coupled to the at least one processor; and

a non-transitory processor-readable storage medium communicatively coupled to the at least one processor, the non-transitory processor-readable storage medium storing a library of reusable grasp primitives and processor-executable instructions that, when executed by the at least one processor, cause the robot to:

collect data about the object;

analyze the data to determine a geometry of the object;

select a particular reusable grasp primitive from the library of reusable grasp primitives based, at least in part, on the geometry of the object; and

execute the particular reusable grasp primitive to grasp the object.

12. The robot of claim 11 wherein the processor-executable instructions that, when executed by the at least one processor, cause the robot to execute the particular reusable grasp primitive to grasp the object, cause the robotic hand to autonomously perform the particular reusable grasp primitive to grasp the object.

13. The robot of claim 11 wherein the at least one sensor includes at least one optical sensor, and wherein the processor-executable instructions that, when executed by the at least one processor, cause the robot to collect data about the object, cause the at least one optical sensor to collect optical data about the object.

14. The robot of claim 11 wherein the processor-executable instructions that, when executed by the at least one processor, cause the robot to select a particular reusable grasp primitive from the library of reusable grasp primitives based, at least in part, on the geometry of the object, cause the robot to select the particular reusable grasp primitive that best fits the geometry of the object relative to all other reusable grasp primitives in the library of reusable grasp primitives.

15. The robot of claim 14 wherein the processor-executable instructions that, when executed by the at least one processor, cause the robot to select the particular reusable grasp primitive that best fits the geometry of the object, cause the robot to select the particular reusable grasp primitive that employs a configuration of the multiple fingers and the opposable thumb of the robotic hand that best accommodates the geometry of the object relative to all other reusable grasp primitives in the library of reusable grasp primitives.

16. The robot of claim 11 wherein the processor-executable instructions that, when executed by the at least one processor, cause the robot to select a particular reusable grasp primitive from the library of reusable grasp primitives based, at least in part, on the geometry of the object, cause the robot to simulate the robotic hand grasping the object with each reusable grasp primitive in the library of reusable grasp primitives to determine which particular reusable grasp primitive in the library of reusable grasp primitives best fits the geometry of the object relative to all other grasp primitives in the library of reusable grasp primitives.

17. The robot of claim 11 wherein the non-transitory processor-readable storage medium further stores processor-executable instructions that, when executed by the at least one processor, cause the robot to analyze additional data about the object to determine at least one additional parameter of the object, and wherein the processor-executable instructions that, when executed by the at least one processor, cause the robot to select a particular reusable grasp primitive from the library of reusable grasp primitives based, at least in part, on the geometry of the object, cause the robot to select a particular reusable grasp primitive from the library of reusable grasp primitives based, at least in part, on both the geometry of the object and the at least one additional parameter of the object.

18. The robot of claim 17 wherein the non-transitory processor-readable storage medium further stores processor-executable instructions that, when executed by the at least one processor, cause the robot to collect the additional data about the object, and wherein the additional data about the object is selected from a group consisting of: a hardness of the object, a rigidity of the object, an identity of the object, a function of the object, and a mass of the object.

19. The robot of claim 17, further comprising:

at least one receiver communicatively coupled to the at least one processor, and wherein the non-transitory processor-readable storage medium further stores processor-executable instructions that, when executed by the at least one processor, cause the robot to receive the additional data about the object.

20. The robot of claim 11 wherein the non-transitory processor-readable storage medium further stores data about a work objective to be performed by the robot, the work objective involving grasping the object, and wherein the processor-executable instructions that, when executed by the at least one processor, cause the robot to select a particular reusable grasp primitive from the library of reusable grasp primitives based, at least in part, on the geometry of the object, cause the robot to select the particular reusable grasp primitive from the library of reusable grasp primitives based, at least in part, on both the geometry of the object and the data about the work objective to be performed by the robot.

21. A computer-implemented method of initializing a robot to complete a multitude of work objectives, the method comprising:

defining a library of reusable work primitives each performable by the robot, wherein respective combinations and permutations of reusable work primitives from the library of reusable work primitives are initiated and executed by the robot in order to complete respective work objectives;

training the robot to autonomously perform each reusable work primitive in the library of reusable work primitives, wherein the training the robot comprises:

generating a simulated instance of the robot in a simulated environment;

receiving teleoperation instructions that cause the robot to perform a first reusable work primitive in the library of reusable work primitives including receiving teleoperation instructions that cause the simulated instance of the robot to perform the first reusable work primitive in the simulated environment;

executing the teleoperation instructions to cause the robot to perform the first reusable work primitive in the library of reusable work primitives including executing the teleoperation instructions to cause the simulated instance of the robot to perform the first reusable work primitive in the simulated environment; and

generating processor-executable instructions that cause the robot to replay the teleoperation instructions that cause the robot to perform the first reusable work primitive in the library of reusable work primitives including generating processor-executable instructions that cause the simulated instance of the robot to replay the teleoperation instructions that cause the simulated instance of the robot to perform the first reusable work primitive in the simulated environment.

22. The method of claim 21 wherein receiving teleoperation instructions that cause the robot to perform a first reusable work primitive in the library of reusable work primitives includes receiving low-level teleoperation instructions that cause the robot to emulate real physical actions performed by a real teleoperation pilot.

23. The method of claim 21 wherein receiving teleoperation instructions that cause the robot to perform a first reusable work primitive in the library of reusable work primitives includes receiving high-level teleoperation instructions that cause the robot to perform actions selected from a graphical user interface.

24. The method of claim 21 wherein receiving teleoperation instructions that cause the simulated instance of the robot to perform the first reusable work primitive in the simulated environment includes receiving low-level teleoperation instructions that cause the simulated instance of the robot to emulate real physical actions performed by a real teleoperation pilot.

25. The method of claim 21 wherein receiving teleoperation instructions that cause the simulated instance of the robot to perform the first reusable work primitive in the simulated environment includes receiving high-level teleoperation instructions that cause the simulated instance of the robot to perform actions selected from a graphical user interface.

26. The method of claim 21 wherein:

receiving teleoperation instructions that cause the robot to perform a first reusable work primitive in the library of reusable work primitives includes receiving a first set of teleoperation instructions that cause the robot to perform a first instance of the first reusable work primitive in the library of reusable work primitives and receiving a second set of teleoperation instructions that cause the robot to perform a second instance of the first reusable work primitive in the library of reusable work primitives; and

executing the teleoperation instructions to cause the robot to perform the first reusable work primitive in the library of reusable work primitives includes executing the first set of teleoperation instructions to cause the robot to perform the first instance of the first reusable work primitive in the library of reusable work primitives and executing the second set of teleoperation instructions to cause the robot to perform the second instance of the first reusable work primitive in the library of reusable work primitives.

27. The method of claim 26 wherein generating processor-executable instructions that cause the robot to replay the teleoperation instructions that cause the robot to perform the first reusable work primitive in the library of reusable work primitives includes:

evaluating respective results of executing the first set of teleoperation instructions to cause the robot to perform the first instance of the first reusable work primitive in the library of reusable work primitives and executing the second set of teleoperation

instructions to cause the robot to perform the second instance of the first reusable work primitive in the library of reusable work primitives to determine which of the first set of teleoperation instructions and the second set of teleoperation instructions produces a better result; and

generating processor-executable instructions that cause the robot to replay whichever of the first set of teleoperation instructions and the second set of teleoperation instructions that produces the better result.

28. The method of claim 26 wherein generating processor-executable instructions that cause the robot to replay the teleoperation instructions that cause the robot to perform the first reusable work primitive in the library of reusable work primitives includes combining at least one element of the first set of teleoperation instructions and at least one element of the second set of teleoperation instructions in the processor-executable instructions that cause the robot to replay the teleoperation instructions that cause the robot to perform the first reusable work primitive in the library of reusable work primitives.

29. The method of claim 21 wherein training the robot to autonomously perform each reusable work primitive in the library of reusable work primitives includes generating processor-executable instructions that, when executed by at least one processor of the robot, cause the robot to autonomously perform each reusable work primitive in the library of reusable work primitives, and the method further comprising:

delivering the processor-executable instructions to a non-transitory processor-readable storage medium of the robot.