AMENDMENTS TO THE CLAIMS

1. (Original) A thumb assembly for an underactuated end effector for a humanoid robot, the thumb assembly comprising:

a frame;

a sagittal plane;

a motor assembly removably coupled to the frame and including both a first motor and a second motor;

a base joint assembly coupled to the frame and comprising:

a flexion gear configured to be driven by the first motor, and wherein the first motor has a first motor shaft that is oriented at a first acute angle relative to the sagittal plane;

an interposition gear configured to be driven by the second motor, and wherein the second motor has a second motor shaft that is oriented at a second acute angle relative to the sagittal plane, and wherein the first acute angle is approximately equal to the second acute angle;

a first carpometacarpal joint formed between an extent of the base joint assembly and a digit assembly, and wherein movement of the interposition gear using the second motor causes the digit assembly to rotate about a first carpometacarpal joint axis of the first carpometacarpal joint; and

the digit assembly coupled to the base joint assembly and comprising:

a proximal assembly;

a second carpometacarpal joint pivotably coupling the proximal assembly to an extent of the base joint assembly, and wherein movement of the flexion gear using the first motor causes the digit assembly to rotate about a second carpometacarpal joint axis of the second carpometacarpal joint;

a proximal interphalangeal joint pivotably coupling the proximal assembly to a medial assembly; and

a distal interphalangeal joint pivotably coupling the medial assembly to a distal assembly.

2. (Original) The thumb assembly of claim 1, further comprising a carpometacarpal joint housing assembly configured to rotate in response to rotation of the interposition gear.
3. (Original) The thumb assembly of claim 2, wherein the carpometacarpal joint housing assembly includes an upper edge that is positioned proximate to a lower extent of a palm housing, and wherein said palm housing overlies an extent of the motor assembly.
4. (Original) The thumb assembly of claim 1, the thumb assembly further comprising:

    a carpometacarpal joint housing assembly having a base joint receiver; and

    a proximal housing assembly including a rear extent that is positioned within the base joint receiver when the thumb assembly is in an uncurled position, and wherein said rear extent of the proximal housing assembly is not positioned within the base joint receiver when the thumb assembly is in a curled position.
5. (Original) The thumb assembly of claim 1, wherein the proximal interphalangeal joint has a range of motion between 55 and 90 degrees.
6. (Original) The thumb assembly of claim 1, wherein the distal interphalangeal joint has a range of motion between 35 and 57 degrees.
7. (Original) The thumb assembly of claim 1, wherein the first carpometacarpal joint has a range of motion between 80 and 160 degrees, and the second carpometacarpal joint has a range of motion between 35 and 65 degrees.
8. (Original) The thumb assembly of claim 1, further comprising a rotation encoder positioned proximate the first carpometacarpal joint and configured to collect data related to rotation of the first carpometacarpal joint.
9. (Original) The thumb assembly of claim 1, wherein the thumb assembly is covered by a textile covering.

10. (Original) A thumb assembly for an underactuated end effector for a humanoid robot, the thumb assembly comprising:

a frame;

a motor assembly removably coupled to the frame and including both a first motor and a second motor;

a base joint assembly coupled to the frame and comprising:

a flexion gear configured to be driven by the first motor;

an interposition gear configured to be driven by the second motor;

a first carpometacarpal joint formed between an extent of the base joint assembly and a digit assembly, and wherein movement of the interposition gear using the second motor causes the digit assembly to rotate about a first carpometacarpal joint axis of the first carpometacarpal joint;

a carpometacarpal joint housing assembly configured to rotate in response to rotation of the interposition gear; and

the digit assembly coupled to the base joint assembly and comprising:

a proximal assembly;

a second carpometacarpal joint pivotably coupling the proximal assembly to an extent of the base joint assembly, and wherein movement of the flexion gear using the first motor causes the digit assembly to rotate about a second carpometacarpal joint axis of the second carpometacarpal joint;

a proximal interphalangeal joint pivotably coupling the proximal assembly to a medial assembly; and

a distal interphalangeal joint pivotably coupling the medial assembly to a distal assembly.

11. (Original) The thumb assembly of claim 10, wherein:

the first motor includes a first motor shaft that is rotatable about a first motor shaft axis;

the second motor includes a second motor shaft that is rotatable about a second motor shaft axis; and

the first motor shaft axis is oriented substantially parallel to the second motor shaft axis.

12. (Original) The thumb assembly of claim 10, the thumb assembly further comprising:

a proximal housing assembly including a rear extent that is positioned within the base joint receiver when the thumb assembly is in an uncurled position, and wherein said rear extent of the proximal housing assembly is not positioned within the base joint receiver when the thumb assembly is in a curled position, and

wherein the carpometacarpal joint housing assembly has a base joint receiver; and.

13. (Original) The thumb assembly of claim 10, further comprising: (i) a first encoder positioned proximate to the proximal interphalangeal joint and configured to collect data related to rotation of the proximal interphalangeal joint, and (ii) a second encoder positioned proximate to the distal interphalangeal joint and configured to collect data related to rotation of the distal interphalangeal joint.
14. (Original) The thumb assembly of claim 10, wherein the thumb assembly is covered by a textile covering.
15. (Original) The thumb assembly of claim 10, wherein the frame includes a palm region, and wherein the first motor and the second motor are at least partially located within the palm region of the frame.
16. (Original) The thumb assembly of claim 10, wherein the flexion gear is rotatable about a flexion axis, and wherein the flexion axis is oriented perpendicular to a first motor shaft axis of the first motor.
17. (Original) The thumb assembly of claim 10, wherein the thumb assembly further comprises both a biasing member coupled to an extent of the proximal assembly and an extent of the medial assembly, and wherein the biasing member is configured to bias the medial assembly toward an uncurled position.

18. (Original) An end effector for a humanoid robot, the end effector comprising:

a frame;

a plurality of finger assemblies connected to the frame, each finger assembly of the plurality of finger assemblies comprising:

a metacarpophalangeal joint;

a proximal finger interphalangeal joint;

a distal finger interphalangeal joint; and

a thumb assembly removably connected to the frame, the thumb assembly comprising:

a first carpometacarpal joint;

a second carpometacarpal joint;

a metacarpophalangeal joint;

an interphalangeal joint;

a carpometacarpal joint housing assembly having a base joint receiver;

a proximal housing assembly including a rear extent that is positioned within the base joint receiver when the thumb assembly is in an uncurled position, wherein said rear extent of the proximal housing assembly is positioned external to the base joint receiver when the thumb assembly is in a curled position;

a carpometacarpal encoder positioned proximate to the first carpometacarpal joint and configured to collect data concerning rotation of the first carpometacarpal joint;

a first thumb encoder positioned proximate to the metacarpophalangeal joint and configured to collect data concerning rotation of the metacarpophalangeal joint; and

a second thumb encoder positioned proximate the interphalangeal joint and configured to collect data concerning rotation of the interphalangeal joint, and wherein the first thumb encoder and second thumb encoder are positioned adjacent to a main medial link of the thumb assembly.

19. (Original) The end effector of claim 18, wherein the thumb assembly further comprises: (i) a first motor gear, (ii) a worm wheel configured to facilitate movement of the thumb assembly between an uncurled position and a curled position, and (iii) a thumb drive assembly in geared engagement with the first motor gear and the worm wheel.
20. (Original) The end effector of claim 19, wherein the thumb drive assembly further includes: (i) a flexion gear in geared engagement with the first motor gear, (ii) a worm drive gear in geared engagement with the worm wheel, and (iii) a drive shaft coupled to both the flexion gear and the worm drive gear.
21. (Original) The end effector of claim 18, wherein the frame includes a palm region, and wherein the first motor and the second motor are at least partially located within the palm region of the frame.
22. (Original) The end effector of claim 18, wherein the thumb assembly is configured to covered by a textile covering.
23. (Original) The end effector of claim 18, wherein the end effector has at least 2.66 degrees of freedom per motor.
24. (Currently Amended) The end effector ~~thumb assembly~~ of claim 18, further comprising a carpometacarpal joint housing assembly configured to rotate in response to rotation of an interposition gear.