Claims

1. A robotic gripper comprising:

a body;

a plurality of displacement mechanisms;

a plurality of finger modules removably connected or connectable to the body, such that each finger module engages with a respective displacement mechanism;

each finger module comprising:

a finger actuator cooperative with the other finger actuators for gripping an object; and

a tactile sensor for measuring a contact force between the respective finger module and the object; and

a control module configured for:

controlling actuation of each finger actuator to grip the object; and

controlling each displacement mechanism for moving the respective finger module to adjust its arrangement on the body, thereby configuring the robotic gripper for gripping the object;

attempting a plurality of grip configurations for gripping the object;

measuring, using the tactile sensors, the contact forces for each grip configuration;

searching for a suitable grip configuration among the attempted grip configurations based on the measured contact forces; and

controlling the displacement mechanisms to adjust the arrangement of the finger modules on the body according to the suitable grip configuration.

2. The robotic gripper according to claim 1, wherein the control module is configured for controlling each displacement mechanism for linear and/or rotational displacement of the respective finger module with respect to the body.

3. The robotic gripper according to claim 1 or 2, wherein each finger actuator comprises:

a resilient element arranged along a length of the finger actuator for stiffening the finger actuator; and

a cover plate and an inflatable channel having a proximal portion and a distal portion, the cover plate and the proximal fluidic channel portion arranged at a proximal section of the finger actuator along the length of the finger actuator, the distal fluidic channel portion arranged at a distal section of the finger actuator along the length of the finger actuator, the resilient element disposed and freely moveable in a space between the cover plate and the proximal fluidic channel portion when the proximal fluidic channel portion is not inflated,

wherein upon inflation of the proximal fluidic channel portion, the inflated proximal fluidic channel portion presses the resilient element against the cover plate, thereby stiffening the finger actuator;

wherein upon actuation and bending of the finger actuator by inflation of the distal fluidic channel portion, the resilient element moves, as the finger actuator bends, from the proximal section towards the distal section of the finger actuator; and

wherein the inflated proximal fluidic channel portion blocks the space formed with the cover plate and prevents the resilient plate from returning from the distal section to the proximal section, thereby locking the bent finger actuator.

4. The robotic gripper according to any one of claims 1 to 3, wherein each finger actuator comprises:

a number of smaller-width bellow-shaped sections at a proximal section of the finger actuator; and

a number of larger-width bellow-shaped sections at a distal section of the finger actuator.

5. The robotic gripper according to any one of claims 1 to 4, wherein each finger module comprises a sleeve for wearing over the finger actuator.

6. The robotic gripper according to any one of claims 1 to 5, wherein said searching of the suitable grip configuration comprises ranking the attempted grip

configurations based on intensity of fluctuations in variance and covariance trends of the measured contact forces.

7. The robotic gripper according to any one of claims 1 to 6, wherein the robotic gripper is cooperative with a vision system for detection of a plurality of objects for gripping by the robotic gripper, and wherein the control module is configured for determining the suitable grip configuration for gripping each object based on object detection information from the vision system.

8. A method for configuring a robotic gripper, the method comprising:

operating the robotic gripper comprising a plurality of finger modules and a plurality of displacement mechanisms, the finger modules removably connected to a body of the robotic gripper;

engaging each finger module with a respective displacement mechanism;

arranging the finger modules for gripping an object, each finger module comprising:

a finger actuator cooperative with the other finger actuators for gripping the object; and

a tactile sensor for measuring a contact force between the respective finger module and the object;

moving, using the respective displacement mechanisms, one or more finger modules to adjust their arrangement on the body, thereby configuring the robotic gripper for gripping the object;

actuating each finger actuator to grip the object;

measuring, using the respective tactile sensor, the contact force between the respective finger module and the object;

attempting a plurality of grip configurations for gripping the object;

measuring the contact forces for each grip configuration;

searching for a suitable grip configuration among the attempted grip configurations based on the measured contact forces; and

adjust, using the respective displacement mechanisms, the arrangement of the finger modules on the body according to the suitable grip configuration.

9. The method according to claim 8, wherein moving of the finger modules comprises linear and/or rotational displacement of the respective finger module with respect to the body.

10. A computer program comprising computer executable instructions that, when executed by a processor, cause the processor to control an additive manufacturing apparatus to manufacture a product comprising the robotic gripper according to any one of claims 1 to 7.

11. A method of manufacturing a product via additive manufacturing, the method comprising:

obtaining an electronic file representing a geometry of the product wherein the product comprises the robotic gripper according to any one of claims 1 to 7; and

controlling an additive manufacturing apparatus to manufacture, over one or more additive manufacturing steps, the product according to the geometry specified in the electronic file.

12. A finger actuator comprising:

a resilient element arranged along a length of the finger actuator for stiffening the finger actuator; and

a cover plate and an inflatable channel having a proximal portion and a distal portion, the cover plate and the proximal fluidic channel portion arranged at a proximal section of the finger actuator along the length of the finger actuator, the distal fluidic channel portion arranged at a distal section of the finger actuator along the length of the finger actuator, the resilient element disposed and freely moveable in a space between the cover plate and the proximal fluidic channel portion when the proximal fluidic channel portion is not inflated,

wherein upon inflation of the proximal fluidic channel portion, the inflated proximal fluidic channel portion presses the resilient element against the cover plate, thereby stiffening the finger actuator;

wherein upon actuation and bending of the finger actuator by inflation of the distal fluidic channel portion, the resilient element moves, as the finger

actuator bends, from the proximal section towards the distal section of the finger actuator; and

wherein the inflated proximal fluidic channel portion blocks the space formed with the cover plate and prevents the resilient element from returning from the distal section to the proximal section, thereby locking the bent finger actuator.

13. The finger actuator according to claim 12, wherein each finger actuator comprises:

a number of smaller-width bellow-shaped sections at the proximal section of the finger actuator; and

a number of larger-width bellow-shaped sections at the distal section of the finger actuator.

14. A computer program comprising computer executable instructions that, when executed by a processor, cause the processor to control an additive manufacturing apparatus to manufacture a product comprising the finger actuator according to claim 12 or 13.

15. A method of manufacturing a product via additive manufacturing, the method comprising:

obtaining an electronic file representing a geometry of the product wherein the product comprises the finger actuator according to claim 12 or 13; and

controlling an additive manufacturing apparatus to manufacture, over one or more additive manufacturing steps, the product according to the geometry specified in the electronic file.

16. A method for locking a bending profile of a finger actuator, the method comprising:

disposing a resilient element along a length of the finger actuator and in a space between a cover plate and a proximal portion of an inflatable fluidic channel arranged at a proximal section of the finger actuator along the length

of the finger actuator, the resilient element being freely moveable in the space when the proximal fluidic channel portion is not inflated;

inflating the proximal fluidic channel portion;

pressing, by the inflated proximal fluidic channel portion, the resilient element against the cover plate;

stiffening the finger actuator upon said pressing of the resilient element against the cover plate;

inflating a distal portion of the fluidic channel to actuate the finger actuator, the distal fluidic channel portion arranged at a distal section of the finger actuator along the length of the finger actuator;

upon inflation of the distal fluidic channel portion, actuating and bending the finger actuator and moving the resilient element from the proximal section towards the distal section as the finger actuator bends;

blocking, by the inflated proximal fluidic channel portion, the space formed with the cover plate; and

preventing the resilient element from returning from the distal section to the proximal section, thereby locking the bent finger actuator.