SELF-ALIGNING GRIPPER ASSEMBLIES FOR ROBOTIC ARMS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. provisional patent Application No. 63/486,741, filed February 24, 2023, which is hereby incorporated herein by reference in its entirety.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable.

BACKGROUND

[0003] Robotic arms are utilized in a wide array of industries for automating with speed and precision repetitive tasks that would otherwise conventionally be performed manually. Robotic arms typically include a first end or base and a second or free end opposite the base and which may have one or more degrees of freedom relative to the base which may be moveable or fixed relative to a support structure of the system in which the robotic arm is incorporated. As an example, robotic arms may include one or more articulating joints, actuators (linear, rotary, etc.), and other components to allow for the free end of the robotic arm to move and be positioned as desired by an operator of the robotic arm. Additionally, robotic arms may include a tool at the free end thereof for manipulating one or more workpieces or other objects as part of performing the tasks given to the robotic arm. For example, the robotic arm may include a cutting element, a welding element, or other tool for manipulating an object. As another example, the robotic arm may include one or more grippers for gripping an object such that the robotic arm may pick up and reposition the object as desired.

BRIEF SUMMARY OF THE DISCLOSURE

[0004] According to a first aspect, there is provided a a gripper assembly for a robotic arm including a gripper finger having a longitudinal first end and a longitudinal second end opposite the first end, a gripper pad pivotably coupled to the gripper finger such that the gripper pad is permitted to rotate about a rotational axis relative to the gripper finger, the gripper pad having a pair of lateral sides with one of the lateral sides forming a gripping surface configured to grip an object, and a proximal side located between the pair of lateral sides, and a gripper pad aligner comprising a pad alignment element coupled to the gripper pad and a finger alignment element coupled to the gripper finger, wherein the pad alignment element is coupled to the finger alignment element and configured to apply an aligning

torque to the gripper pad that, when applied, rotates the gripper pad toward a first angular orientation about the rotational axis between the gripper pad and the gripper finger; wherein the pad alignment element comprises a biasing finger having a fixed end coupled to the finger alignment element and a free end opposite the fixed end, and wherein the biasing force applied by the biasing finger results from a bending of the biasing finger.

In some embodiments, the pad alignment element comprises a biasing member configured to apply a biasing force to the gripper pad that, when applied, rotates the gripper pad toward the first angular orientation. In some embodiments, the biasing member comprises a spring wire and the biasing force applied by the spring wire results from an elongation of the spring wire. In certain embodiments, the pad alignment element comprises a biasing finger having a fixed end coupled to the finger alignment element and a free end opposite the fixed end, and wherein the biasing force applied by the biasing finger results from a bending of the biasing finger. In certain embodiments, the finger alignment element comprises a base securable to the gripper finger and the pad alignment element comprises a biasing finger extending from the base toward the gripper pad, and wherein at least a portion of the biasing finger abuts one of the lateral sides of the gripper pad to bias the gripper pad toward the first angular orientation. In some embodiments, the pad alignment element comprises a plurality of the biasing fingers each abutting a first lateral side of the pair of lateral sides of the gripper pad to bias the gripper pad toward the first angular orientation. In some embodiments, the pad alignment element comprises a first magnetic member and the finger alignment element comprises a second magnetic member magnetically coupled to and magnetically attracted toward the first magnetic member. In certain embodiments, the second magnet member is formed integrally with the gripper finger. In certain embodiments, the second magnetic member comprises a boss surrounded by a channel formed in a surface of the gripper finger, and wherein the boss extends toward the proximal side of the gripper pad and is aligned with the first magnetic member when the gripper finger is in the first angular orientation. In some embodiments, the boss comprises a magnetic material and is integrally formed with the gripper finger. In some embodiments, the boss is attachable to the gripper finger and comprises a magnetic material that is different from a material comprising the gripper finger. In certain embodiments, the first magnetic member comprises a magnet attachable to the gripper pad. In some embodiments, the gripper assembly comprises a pivot pin extending from the gripper finger to the proximal side of the gripper pad to pivotably couple the gripper pad to the gripper finger. An embodiment of an assay system comprises a container containing a reagent, and a pair of robotic arms configured to manipulate the position of the container, wherein each of the robotic arms comprises a pair of the gripper assemblies configured to grip the container between the pair of robotic arms.

[0005] According to a second aspect, there is provided a gripper assembly for a robotic arm including a gripper finger having a longitudinal first end and a longitudinal second end opposite the first end, a gripper pad pivotably coupled to the gripper finger such that the gripper pad is permitted to rotate about a rotational axis relative to the gripper finger, the gripper pad having a pair of lateral sides with one of the lateral sides forming a gripping surface configured to grip an object, and a proximal side located between the pair of lateral sides, and a gripper pad aligner comprising a base formed monolithically with the finger, and a pad alignment element coupled to the gripper finger and offset from the rotational axis by a predetermined distance, wherein the pad alignment element is configured to apply an aligning torque to the gripper pad oriented in the direction of a first angular orientation about the rotational axis between the gripper pad and the gripper finger.

In some embodiments, the pad alignment element comprises a magnetic member received in an aperture formed in the proximal side of the gripper pad. In some embodiments, the gripper pad aligner comprises a magnetic boss extending from a side of the gripper finger and surrounded by a channel formed in the side of the gripper finger, and wherein the magnetic boss magnetically attracts the pad alignment element and is aligned with the pad alignment element when the gripper finger is in the first angular orientation. In certain embodiments, the boss comprises a magnetic material and is integrally formed with the gripper finger. In certain embodiments, the boss is attachable to the gripper finger and comprises a magnetic material that is different from a material comprising the gripper finger. In some embodiments, the pad alignment element comprises a magnet coupled to the gripper pad. In some embodiments, the pad alignment element comprises an elongate biasing finger which abuts one of the pair of lateral sides of the gripper pad and extends toward the gripper finger. In certain embodiments, the pad alignment element comprises a spring wire and the aligning torque comprises a biasing force applied by the spring wire due to an elongation of the spring wire. In certain embodiments, the gripper pad aligner comprises a finger alignment element coupled to the gripper pad and offset from the rotational axis by the predetermined distance. In some embodiments, the pad alignment element comprises a first magnetic member and the finger alignment element comprises a second magnetic member magnetically attracted toward the pad alignment element. In some embodiments, the gripper pad comprises a second angular orientation that is spaced from the first angular orientation in a first rotational direction about the rotational axis, and wherein the alignment element applies a rotational torque in a second rotational direction, opposite the first rotational direction, when the gripper pad is in the second angular orientation, and the gripper pad comprises a third angular orientation that is spaced from the first angular orientation in the second rotational direction about the rotational axis, and wherein the alignment element applies a rotational torque in the first rotational direction

when the gripper pad is in the third angular orientation. In certain embodiments, the alignment element is configured to restore the gripper pad to the first angular orientation when the gripper pad is in a second angular orientation spaced from the first angular orientation in a first rotational direction, and when the gripper pad is in a third angular orientation spaced from the first angular orientation in a second rotational direction, opposite the first rotational direction. In certain embodiments, the gripper assembly comprises a pivot pin extending from the gripper finger to the proximal side of the gripper pad to pivotably couple the gripper pad to the gripper finger.

[0006] According to a third aspect, there is provided a gripper assembly for a robotic arm including a gripper finger having a longitudinal first end and a longitudinal second end opposite the first end, a gripper pad pivotably coupled to the gripper finger such that the gripper pad is permitted to rotate about a rotational axis relative to the gripper finger, the gripper pad having a pair of lateral sides with one of the lateral sides forming a gripping surface configured to grip an object, and a proximal side located between the pair of lateral sides, and a first gripper pad aligner comprising a first finger alignment element that comprises a first base securable to the gripper finger, and a first pad alignment element comprising a first biasing finger extending from the first base toward the gripper pad and abutting one of the lateral sides of the gripper pad; and a second gripper pad aligner comprising a second finger alignment element that comprises a second base securable to the gripper finger, and a second pad alignment element comprising a second biasing finger extending from the second base toward the gripper pad and abutting one of the lateral sides of the gripper pad.

In some embodiments, the gripper pad aligner comprises a plurality of the biasing fingers each abutting a first lateral side of the pair of lateral sides of the gripper pad to bias the gripper pad toward a first angular orientation. In some embodiments, the gripper pad comprises a second angular orientation that is spaced from the first angular orientation in a first rotational direction about the rotational axis, and wherein a first biasing finger of the plurality of the biasing fingers applies a rotational torque in a second rotational direction, opposite the first rotational direction, when the gripper pad is in the second angular orientation, and the gripper pad comprises a third angular orientation that is spaced from the first angular orientation in the second rotational direction about the rotational axis, and wherein a second biasing finger of the plurality of the biasing fingers applies a rotational torque in the first rotational direction when the gripper pad is in the third angular orientation. In certain embodiments, the gripper pad aligner is configured to restore the gripper pad to the first angular orientation when the gripper pad is in a second angular orientation spaced from the first angular orientation in a first rotational direction, and when the gripper pad is in a third angular orientation spaced from the first angular orientation in a second rotational

direction, opposite the first rotational direction. In certain embodiments, the biasing finger comprises a pair of the biasing fingers each abutting a first lateral side of the pair of lateral sides of the gripper pad, and wherein the pair of the biasing fingers are at locations spaced from each other along a longitudinal axis of the gripper pad. In some embodiments, the base of the gripper pad aligner is formed monolithically with the finger.

[0007] According to a fourth aspect, there is provided a gripper assembly for a robotic arm including a gripper finger having a longitudinal first end and a longitudinal second end opposite the first end, a gripper pad having a pair of lateral sides with one of the lateral sides forming a gripping surface configured to grip an object, and a proximal side located between the pair of lateral sides, and a gripper pad aligner comprising a first magnetic member coupled to the gripper finger and a second magnetic member coupled to the gripper pad and magnetically attracted to the first magnetic member, wherein the second magnetic member is configured to apply an aligning torque to the gripper pad oriented in the direction of a first angular orientation about a rotational axis between the gripper pad and the gripper finger.

[0008] According to a fifth aspect, there is provided a gripper pad aligner for a gripper assembly of a robotic arm including a pad alignment element configured to couple to a gripper pad of the gripper assembly, and a finger alignment element configured to couple to a gripper finger of the gripper assembly, wherein the pad alignment element is configured to couple to the finger alignment element and configured to apply an aligning torque to the gripper pad when the finger alignment element is coupled to the gripper pad that, when applied, rotates the gripper pad toward a first angular orientation about a rotational axis between the gripper pad and the gripper finger.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] For a detailed description of various exemplary embodiments, reference will now be made to the accompanying drawings in which:

[0010] Figure 1 is a plan view of an embodiment of an automated assay system including a robotic arm;

[0011] Figure 2 is a side view of an embodiment of a gripper assembly of a robotic arm of Figure 1;

[0012] Figures 3-5 are bottom views of the gripper assembly of Figure 2;

[0013] Figures 6-8 are additional bottom views of a pair of the gripper assemblies of Figure 2;

[0014] Figures 9 and 10 are bottom views of another embodiment of a gripper assembly for a robotic arm;

[0015] Figure 11 is a perspective view of an embodiment of a gripper pad aligner;