

CLAIMS

What is claimed is:

1. An actuation system for actuating a soft robot, the actuation system comprising:
 - a camshaft;
 - a motor configured to drive the camshaft to rotate around a rotational axis;
 - an air bladder configured to expel fluid from the air bladder during compression of the air bladder and draw fluid into the air bladder during decompression of the air bladder;
 - a cam coupled to the camshaft and configured to:
 - rotate around the rotational axis when the camshaft is driven, and
 - compress or decompress the air bladder based on a physical profile of the cam as the cam rotates around the rotational axis; and
 - a soft robot coupled to the air bladder, wherein the soft robot is actuated to move based on the fluid expelled from the air bladder that is inserted into the soft robot during compression of the air bladder or the fluid removed from the soft robot that is drawn into the air bladder during decompression of the air bladder.
2. The actuation system of claim 1, further comprising:
 - a hinge configured to cooperate with the cam; and
 - a finger formed on the hinge,wherein the hinge moves in a direction away from the rotational axis or a direction toward the rotational axis based on the physical profile of the cam as the cam rotates around the rotational axis, and
 - wherein the finger compresses the air bladder as the hinge moves in the direction away from the rotational axis and decompresses the air bladder as the hinge moves in the direction toward the rotational axis.
3. The actuation system of claim 1, wherein the fluid is a liquid or a gas.

4. The actuation system of claim 1, wherein the soft robot is coupled to the air bladder via a hose.
5. The actuation system of claim 1, wherein a volume capacity of the soft robot is equal to a volume capacity of the air bladder.
6. The actuation system of claim 1, further comprising:
 - at least one other air bladder configured to expel fluid from the at least one other air bladder during compression of the at least one other air bladder and draw fluid into the at least one other air bladder during decompression of the at least one other air bladder;
 - at least one other cam coupled to the camshaft and configured to:
 - rotate around the rotational axis when the camshaft is driven, and
 - compress or decompress the at least one other air bladder based on a physical profile of the at least one other cam as the at least one other cam rotates around the rotational axis; and
 - at least one other soft robot coupled to the at least one other air bladder, wherein the at least one other soft robot is actuated to move based on the fluid expelled from the at least one other air bladder that is inserted into the at least one other soft robot during compression of the at least one other air bladder or the fluid removed from the at least one other soft robot that is drawn into the at least one other air bladder during decompression of the at least one other air bladder.
7. The actuation system of claim 6, wherein the cam and the at least one other cam are further configured to compress or decompress the same air bladder.
8. The actuation system of claim 6, wherein:
 - the soft robot comprises a first air chamber and a second air chamber,
 - the air bladder is configured to expel fluid into the first air chamber or draw fluid from the first air chamber, and
 - the at least one other air bladder is configured to expel fluid into the second air chamber or draw fluid from the second air chamber.
9. A method for actuating a soft robot, comprising:

driving a camshaft to rotate around a rotational axis;
rotating a cam coupled to the camshaft around the rotational axis when the camshaft is driven;
compressing or decompressing an air bladder based on a physical profile of the cam as the cam rotates around the rotational axis;
expelling fluid from the air bladder during compression of the air bladder and drawing fluid into the air bladder during decompression of the air bladder; and
actuating a soft robot coupled to the air bladder to move based on the fluid expelled from the air bladder that is inserted into the soft robot during compression of the air bladder or the fluid removed from the soft robot that is drawn into the air bladder during decompression of the air bladder.

10. The method of claim 9, wherein the compressing or decompressing the air bladder comprises:

moving a hinge in a direction away from the rotational axis or a direction toward the rotational axis based on the physical profile of the cam as the cam rotates around the rotational axis; and

compressing the air bladder with a finger formed on the hinge as the hinge moves in the direction away from the rotational axis and decompressing the air bladder with the finger as the hinge moves in the direction toward the rotational axis.

11. The method of claim 9, wherein the fluid is a liquid or a gas.

12. The method of claim 9, wherein the soft robot is coupled to the air bladder via a hose.

13. The method of claim 9, wherein a volume capacity of the soft robot is equal to a volume capacity of the air bladder.

14. The method of claim 9, further comprising:

rotating at least one other cam coupled to the camshaft around the rotational axis when the camshaft is driven;

compressing or decompressing at least one other air bladder based on a physical profile of the at least one other cam as the at least one other cam rotates around the rotational axis;

expelling fluid from the at least one other air bladder during compression of the at least one other air bladder and drawing fluid into the at least one other air bladder during decompression of the at least one other air bladder; and

actuating at least one other soft robot coupled to the at least one other air bladder to move based on the fluid expelled from the at least one other air bladder that is inserted into the at least one other soft robot during compression of the at least one other air bladder or the fluid removed from the at least one other soft robot that is drawn into the at least one other air bladder during decompression of the at least one other air bladder.

15. The method of claim 14, wherein the cam and the at least one other cam compress or decompress the same air bladder.

16. The method of claim 14, wherein:

the soft robot comprises a first air chamber and a second air chamber,

the air bladder expels fluid into the first air chamber or draws fluid from the first air chamber, and

the at least one other air bladder expels fluid into the second air chamber or draws fluid from the second air chamber.

17. An actuation system for actuating a soft robot, the actuation system comprising:

a main camshaft;

a motor configured to drive the main camshaft to rotate around a first rotational axis;

a branch camshaft coupled to the main camshaft in a non-collinear manner, wherein the branch camshaft rotates around a second rotational axis as the main camshaft rotates around the first rotational axis;

an air bladder configured to expel fluid from the air bladder during compression of the air bladder and draw fluid into the air bladder during decompression of the air bladder;

a cam coupled to the branch camshaft and configured to:

rotate around the second rotational axis when the camshaft is driven, and compress or decompress the air bladder based on a physical profile of the cam as the cam rotates around the second rotational axis; and

a soft robot coupled to the air bladder, wherein the soft robot is actuated to move based on the fluid expelled from the air bladder that is inserted into the soft robot during compression of the air bladder or the fluid removed from the soft robot that is drawn into the air bladder during decompression of the air bladder.

18. The actuation system of claim 17, wherein the branch camshaft is coupled to the main camshaft via a universal joint.

19. The actuation system of claim 17, wherein the fluid is a liquid or a gas.

20. The actuation system of claim 17, wherein the soft robot is coupled to the air bladder via a hose.