MEMBRANE POSITION CONTROL

Inventors: Ji Su, Highland Park, NJ (US); Joycelyn S. Harrison, Hampton, VA (US)

Assignee: The United States of America as represented by the Administrator of the National Aeronautics and Space Administration, Washington, DC (US)

Abstract

A membrane structure includes at least one electroactive bending actuator fixed to a supporting base. Each electroactive bending actuator is operatively connected to the membrane for controlling membrane position. Any displacement of each electroactive bending actuator effects displacement of the membrane. More specifically, the operative connection is provided by a guiding wheel assembly and a track, wherein displacement of the bending actuator effects translation of the wheel assembly along the track, thereby imparting movement to the membrane.

6 Claims, 4 Drawing Sheets
OTHER PUBLICATIONS


* cited by examiner
MEMBRANE POSITION CONTROL

CLAIM OF BENEFIT OF PROVISIONAL APPLICATION

Pursuant to 35 U.S.C. §119, the benefit of priority from provisional application No. 60/161,113, with a filing date of Oct. 22, 1999, is claimed for this non-provisional application.

CROSS REFERENCE TO RELATED CASES

This application is related to co-pending, commonly owned patent application Ser. No. 09/696,524, filed Oct. 23, 2000, entitled “Polymer-Polymer Bilayer Actuator”, and co-pending, commonly owned patent application Ser. No. 09/696,526, filed Oct. 23, 2000, entitled “Non-Uniform Thickness Electroactive Device.”

ORIGIN OF THE INVENTION

The invention described herein was made by an employee of the United States Government and a National Research Council Research Associate and may be used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is generally related to the control of membrane structures by electroactive bending actuators.

2. Description of the Related Art

Membrane inflatable and deployable space structures are widely employed by the government and commercially as reflectors, antennas, solar arrays, satellites, solar sails, etc. Although these membrane inflatable and deployable structures are widely used, many challenges exist which limit their performance for high precision applications. Factors affecting precision include surface smoothness, deviation from desired surface profile, surface deformations due to thermal fluctuations, and accurate membrane positioning. Actuation devices are used for many applications, including the shaping, tuning, positioning, controlling and deforming of membrane structures. To operate most effectively in the aforementioned applications, actuation devices require sufficient force and strain, and often need to produce complex motions.

Conventional piezoelectric ceramic, polymer, and composite actuators (including piezoelectric, electrostrictive, and electrostatic) lack the combination of sufficient strain and force to most effectively perform the aforementioned functions. Previous concepts for shaping and tuning membrane structures have primarily involved the use of piezoelectric ceramic materials. These ceramic piezoelectrics have the major problems of large mass, high density, low strain and high brittleness. Generally, piezoceramics also need additional mechanical devices to achieve a shaping, tuning, positioning, controlling or deforming function. In contrast to electroceramics, electroactive polymers are emerging as new actuation materials due to their enhanced strain capabilities.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide an electroactive position control device.

Another object is to provide an electroactive position control device wherein the electroactive components have small mass, low density, high strain and low brittleness.

Another object is to provide an electroactively-controlled membrane.

Another object is to provide an electroactively-controlled membrane inflatable and deployable structure.

Another object is to provide an electroactive position control device using electrostrictive bending actuators.

Additional objects and advantages of the present invention are apparent from the drawings and specification that follow.

In accordance with the present invention, a membrane structure includes an electroactive device fixed to a supporting base. A connection means operatively connects the electroactive device to the membrane for controlling membrane position.

BRIEF DESCRIPTION OF THE INVENTION

A more complete appreciation of the invention and the many of the attendant advantages thereof will be readily attained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. 1 illustrates a membrane structure having integrated electroactive positioning actuators.

FIGS. 2A through 2D illustrate four positioning states of a membrane.

FIG. 3A illustrates a connection means operatively connecting the electroactive device to the membrane for controlling membrane position.

FIG. 3B illustrates a side view of FIG. 3A.

FIG. 3C illustrates a partial cross-sectional view of FIG. 3B.

FIG. 4 is an alternate embodiment of the connection means.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, and more particularly to FIG. 1, a membrane structure according to the present invention is shown and referenced generally by the numeral 100. Membrane 110 is to be controlled. Membrane 110, Supporting frame 140 supports the membrane 110. Supporting base 120 is connected to a strut assembly 130. Strut assembly 130 is connected to additional structure within the overall structural system. The supporting base 120/strut assembly 130 structure is indicative of usual support and overall system interface for membrane structures; however, the present invention is not limited to such specific configuration. Actuators 150, 160 and 170 are affixed to supporting base 120 adjacent to the supporting base 120 periphery. Actuators 150, 160 and 170 bend upon electrical activation. Electrostrictive actuators are preferred due to their high mechanical modulus and strain combination. An especially preferred actuator is the polymer-polymer actuator bed and claimed in “Polymer-Polymer Bilayer Actuator”, Ser. No. 09/696,524, filed Oct. 23, 2000, hereby incorporated by reference. The actuators 150, 160 and 170 can also have non-uniform layer thickness, as that described in and claimed in “Non-Uniform Thickness Electroactive Device”, Ser. No. 09/696,526, filed Oct. 23, 2000, hereby incorporated by reference.

Referring to FIGS. 2A through 2D, connection means 180 operatively connects the membrane 110 and actuators 150 and 160. FIGS. 2A through 2D illustrate four positioning states of a membrane 110. The actuators are in their inacti-
The structure of claim 2, wherein the guiding track is affixed to the membrane by means selected from the group consisting of chemical and mechanical.

4. The structure of claim 3, wherein the guiding wheels are position a sufficient distance form the guiding track to allow free movement of the axle along the guiding track.

5. The structure of claim 2, wherein the guiding wheel assembly is made of a material selected from the group consisting of plastic and metal.

6. The structure of claim 2, wherein the guiding track is made of a material selected from the group consisting of plastic and metal.
It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

The title page should be deleted and substitute therefor the attached title page as shown the attached page.

Drawings.
Replace informal figures 1 through 4 with formal figures 1 through 4 as shown on the attached pages.

Signed and Sealed this Twenty-sixth Day of April, 2005

[Signature]

JON W. DUDAS
Director of the United States Patent and Trademark Office
MEMBRANE POSITION CONTROL.

Inventors: Ji Su, Highland Park, NJ (US); Joyceyn S. Harrison, Hampton, VA (US)

Assignee: The United States of America as represented by the Administrator of the National Aeronautics and Space Administration, Washington, DC (US)

Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 4 days.

Filed: Oct. 23, 2000

Related U.S. Application Data

Provisional application No. 60/161,113 filed on Oct. 22, 1999.

Field of Search

310/330, 310/331

References Cited

U.S. PATENT DOCUMENTS

1,803,274 A * 4/1931 Sawyer .................................. 310/330
2,540,412 A * 2/1951 Adler .................................. 310/330
2,842,685 A * 7/1958 Pizolat et al. ....................... 310/331
3,146,367 A * 8/1964 Meneney ................................ 310/331
3,928,716 A * 12/1975 Ivanov et al. ....................... 310/331
4,578,613 A * 3/1986 Posthaus de Boer et al. ......... 310/331
4,806,647 A * 6/1989 Lee et al. ........................... 310/331
5,413,534 A * 4/1995 Panich et al. ........................ 310/331

Patent No.: US 6,724,130 B1
Date of Patent: Apr. 20, 2004

ABSTRACT

A membrane structure includes at least one electroactive bending actuator fixed to a supporting base. Each electroactive bending actuator is operatively connected to the membrane for controlling membrane position. Any displacement of each electroactive bending actuator affects displacement of the membrane. More specifically, the actuator connection is provided by a guiding wheel assembly and a track, wherein displacement of the bending actuator effects translation of the wheel assembly along the track, thereby imparting movement to the membrane.

Primary Examiner—Mark Budd

References Cited

U.S. PATENT DOCUMENTS

1,803,274 A * 4/1931 Sawyer .................................. 310/330
2,540,412 A * 2/1951 Adler .................................. 310/330
2,842,685 A * 7/1958 Pizolat et al. ....................... 310/331
3,146,367 A * 8/1964 Meneney ................................ 310/331
3,928,716 A * 12/1975 Ivanov et al. ....................... 310/331
4,578,613 A * 3/1986 Posthaus de Boer et al. ......... 310/331
4,806,647 A * 6/1989 Lee et al. ........................... 310/331
5,413,534 A * 4/1995 Panich et al. ........................ 310/331

Primary Examiner—Mark Budd

4 Claims, 4 Drawing Sheets
FIG. 4