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Tailored structural actuation system

Abstract

A device may include a locking assembly configured for coupling with an aileron of an aircraft, the locking assembly includes a lock configured for coupling with the aileron. The locking assembly may include a lock mechanism operatively coupled with the lock and in communication with an accelerometer, where the lock mechanism is configured to transition the lock from a locked configuration to a released configuration. The lock mechanism opens the lock based on a specified acceleration measured with the accelerometer, and the lock frees the aileron to a dynamic configuration. A device may include a tailored aileron deployment system including a biasing member coupled with the aileron, in the released configuration the biasing member controls movement of the aileron in the dynamic configuration.

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Background/Summary

BACKGROUND

(1) Traditional actuation systems for control surfaces in wings are complex, requiring power lines, hydraulic lines, heavy actuators, and power from an auxiliary power unit. Inside confined spaces of aircraft wings there are actuators, along with their plumbing and wiring, to assist in operating control surfaces such as wing flaps and ailerons.

(2) Ailerons are hinged flight control surfaces attached to the trailing edge of the wings of a fixed-wing aircraft. Ailerons are usually found near the wingtips. Traditional ailerons extend along the outboard trailing edges of each wing. Some larger aircraft have two sets of ailerons, one near the wingtip and another inboard, to increase roll control authority.

(3) Ailerons are part of a roll control system and are used to control the aircraft's roll about the aircraft's longitudinal axis. To control the aircraft's roll, the ailerons are moved up or down. For example, when one aileron is raised, the other is lowered, and vice versa. This differential movement changes the lift distribution between the left and right wings, causing the aircraft to roll to the side with the lowered aileron.

(4) Ailerons work change the shape of the wing such that when an aileron is deflected down, the angle of attack increases causing wing will make more lift. More lift alters the angle of the wing such that the wing will start going up and the other wing is angled downward.

SUMMARY

(5) Ailerons change the effective shape of the airfoil of the wing. For example, changing the angle of deflection at a trailing end of a wing changes the amount of lift generated by the airfoil. For instance, with a greater downward deflection, the lift will increase in the upward direction. The ailerons can be actuated mechanically through cables and pulleys, hydraulically, or by using fly-by-wire systems where electronic signals control actuators that move the ailerons. At times, these systems often do not fit within the aircraft's mold line, necessitating additional fairings that can result in undesirable aerodynamic effects.

(6) The inventors have recognized a system for minimizing the control systems used for controlling an aileron. The inventors have recognized a system that includes fewer components for controlling an aileron and optionally decreasing the amount of space occupied by the control systems. For

example, the inventors have recognized a system that does not use mechanics such as hydraulics, powered actuators, cables, pulleys or the like to control or manage a deflection or movement of an aileron. In examples the control system utilizes the aerodynamic load on the aileron to induce the desired deflection of the aileron. The desired deflection can be controlled or managed using a biasing element extending within the wing. In examples, the biasing element is preloaded with tailored, or specified, load to effectively control or manage movement of an aileron, such as a target deflection.

(7) In an example, the aileron is locked in place in a stowed configuration and transitions to an unlocked configuration when specific gravitational forces (“G force”) or centrifugal forces are recognized by an accelerometer. For example, a locking assembly is coupled with the aileron. The locking assembly, for example, includes a lock that is coupled with at least a portion of the aileron and an accelerometer. A locking mechanism is optionally operatively coupled with the lock and in communication with an accelerometer.

(8) In examples, tailored aileron deployment system assembly, and associated management system, includes the locking assembly with the accelerometer that measures the aircraft's acceleration. The acceleration is, for example, related to a specific force such as a gravitational force or centrifugal force. The accelerometer is coupled with a control system that, for example, detects a threshold force and maintains the locking assembly in a locked configuration until the threshold acceleration is measured or the threshold force is detected. The locking assembly includes, for example, the lock mechanism. The lock mechanism is operatively coupled with a lock such that the lock retains the aileron in a neutral orientation, when activated by the locking mechanism, releases the aileron to deflect. For example, the locking mechanism transitions from locked to released configuration based on acceleration, allowing the aileron to move from a static to a dynamic configuration.

(9) When the aileron is in a dynamic configuration, the angle of deflection or rotation of the aileron is optionally controlled or managed by a biasing member. In examples, the biasing member is able to deflect and rotate according to the angle of deflection of the aileron.

(10) This summary is an overview of some of the teachings of the present application and is not intended to be an exclusive or exhaustive treatment of the present subject matter. Further details are found in the detailed description and appended claims. Other aspects will be apparent to persons skilled in the art upon reading and understanding the following detailed description and viewing the drawings that form a part thereof, each of which is not to be taken in a limiting sense. The scope of the present invention is defined by the appended claims and their legal equivalents.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. 1 illustrates an aileron control assembly according to at least one example of the present disclosure.

(2) FIG. 2 illustrates a locking assembly according to at least one example of the present disclosure.

(3) FIG. 3 illustrates an exploded view of an aileron control assembly according to at least one example of the present disclosure.

(4) FIG. 4A illustrates a brace for an aileron control assembly according to at least one example of the present disclosure.

(5) FIG. 4B illustrates an exploded view for of a brace an aileron control assembly according to at least one example of the present disclosure.

(6) FIGS. 5A and 5B illustrates a cross section of a brace according to at least one example of the present disclosure.

(7) FIG. 6 illustrates an example of deflection of the aileron according to at least one example of

the present disclosure.

DETAILED DESCRIPTION

(8) Accommodating actuators and associated plumbing and wiring inside of wings an aircraft can present challenges due to the space allowed in the wing. At times this fit is more challenging proximate to a wing tip of a wing where ailerons of aircraft are located. For example, a challenge is presented to fit actuators, and associated plumbing and wiring for ailerons and exterior control components in the limited volume within the wing proximate to the wing tip. In some examples, systems to actuate control surfaces in the wing include power lines, hydraulic lines, and actuators.

(9) The actuators, in some examples are large and heavy in relation to the size and space of the wing. In examples, the actuators that are used for actuating the control surfaces, such as ailerons, spoilers or flaps, can be so large that they do not fit into the mold line of the aircraft resulting in fairings that need to be placed on the underside of wings which cause undesirable aerodynamic effects.

(10) In some examples, operation of the actuators includes using power from an auxiliary power unit. The auxiliary power unit, in some situations, acquires its power a primary power source. When in operation, power or electricity is distributed to many components of an aircraft. At times this power distribution is prioritized according to specific operations of the aircraft.

(11) The inventors have recognized that minimizing or eliminating mechanical actuation can reduce weight, reduce power requirements, remove complexity, and reduce assembly and maintenance time. The inventors have recognized that using an aileron operatable by available flight energy to actuate a control surface. For example, the aileron operates to provide stress relief at the wing root during a high gravitational force, or centrifugal force, maneuver. For example, a tailored aileron deployment system, and associated assembly, that utilizes the aerodynamic load on the aileron to induce a desired angle of deflection. The angle of deflection is optionally controlled by a tailored stiffness of a biasing member. For example, the stiffness of the biasing member, is formed according to the specifics of the aircraft and the forces the aircraft is subjected to.

(12) In an example, rotation or deflection of the aileron is controlled or managed by holding the aileron in a locked configuration and releasing the aileron to an unlocked configuration. For instance, a locking assembly is included in or proximate to the wing tip. The locking assembly is formed to retain the aileron in a stowed (e.g., original, neutral, retained) configuration or position. The locking assembly, in examples, includes a locking mechanism in communication with control systems where, upon reaching a threshold geometry, the locking mechanism releases the aileron from the stowed configuration to a rotational or dynamic configuration.

(13) FIG. 1 illustrates an example tailored aileron deployment system assembly **100** of a wing **101** of an aircraft. The tailored aileron deployment system assembly **100** is housed within, for example, the wing **101** of an aircraft. The tailored aileron deployment system assembly **100** includes a series of components that cooperatively work together to control (e.g., manage, regulate, adjust or the like) the movement of an aileron **110**. The aileron **110**, for example, is a component of an aircraft wing that offloads forces to the aircraft at the wing **101** at the root **103** of the aircraft. For instance, the aileron **110** minimizes some of the forces applied to the wing **101** proximate to a portion of the wing **101** closest to the fuselage or proximate to a junction of the wing with the fuselage. In an example the aileron **110** is an outboard aileron, or an aileron that is proximate to the wingtip **102**.

(14) Positioning the aileron **110** proximate to the wingtip **102** allows for the aileron **110** to be formed to offload the wing **101** at the root **103**. For example, when the aircraft is operating at high velocities the wing **101** are subjected to increased forces applied to the wing **101**. In examples, when the aircraft is operating at velocities of greater than approximately three Earth gravitational forces (3g's), the forces applied to the wing **101** can cause the wing **101** to bend, flex or deform. For example, the forces causing the wing **101** to bend can begin at the root **103** of the wing **101**. In examples, the aileron **110**, positioned proximate to the wingtip **102**, allows the aileron **110**, when positioned at certain angles, to relieve or minimize some of the forces applied to the aileron **110**

cause the wing **101** to bend.

(15) In examples, when the aircraft enters a high velocity maneuver, the wing **101** bends and the aileron **110** is formed to react in response to the forces applied to the wing. For instance, the aileron **110** reacts gravitational forces or the centrifugal forces of the aircraft and the aileron **110** rotates, or is deflected, about the strut **120** in an effort to offload some of the pressures or forces to the wing **101**. The aileron **110** relieves or minimizes some of the pressure or forces applied to the wing **101** by changing the profile of the wing **101** such as changing the chord of the wing **101**. Optionally, the aileron **110** is connected to internal components within the wing **101** that assist in changing the angle of the aileron **110** relative to the wing **101**. For example, the aileron **110** is connected with the wing with a hinge, strut **120** or the like. The strut **120**, in examples, is a component that permits rotational movement of the aileron **110** about a lateral axis of the wing **101**.

(16) In some examples, to control the aileron **110** a biasing member **150** extends from proximate to the root **103** of the wing **101** through the internal structure of the wing **101** to a position proximate to the aileron **110**. The biasing member **150** is, for example, a torque tube designed to utilize aerodynamic forces to actuate control surfaces, such as the aileron **110**. For instance, the biasing member **150** is a tailored torque tube that adjusts its torsional stiffness to use the aerodynamic load on the aileron **110** to induce the desired deflection. The biasing member **150** is tailored to have torsional stiffness to achieve the desired aileron **110** deflection using the aerodynamic load on the aileron **110**. The biasing member **150** is a mechanical component used to transmit rotational forces from one part of an aircraft to another, such as the control systems that manage the aircraft's flight surfaces such as the aileron **110**. For example, one end of the biasing member **150** is coupled to a fixed coupling **152** proximate to the root **103**. The fixed coupling **152** retains the biasing member **150** in a static, or nonrotational, position at a root end **151** of the biasing member **150**. The biasing member **150** extends from the root end **151** to a position proximate to, for example, a fuselage facing portion **111** of the aileron **110**. In another example, the biasing member **150** extends from the root end **151** to a fuselage facing portion **121** of the strut **120**. Hereinafter the portion of the biasing member **150** proximate to either the fuselage facing portion **111** or the fuselage facing portion **121** includes a second portion **155** of the biasing member **150**.

(17) In examples, the second portion **155** is rotationally coupled with the aileron **110**. In an example, the second portion **155** is formed to control the movement of the aileron **110**. For example, the biasing member **150** includes or is a torsional spring. In examples, the biasing member **150** is formed from composite materials that have biasing capabilities similar to a torsional spring. For example, the material selected for the biasing member **150** includes those having resilience and ability to return to its original shape after deformation, such as a unidirectional composite tape. For example, the composite material that forms the biasing member **150** is selected from materials that can withstand a twist or rotation up to approximately 45 degrees. In another example, the material selected can withstand a twist or rotation up to approximately 30 degrees. In examples, the composite material selected withstands the twist or rotation and spring back, or return, to its original configuration when a pressure or load is applied to the biasing member **150**.

(18) In examples, the biasing member **150** includes a spiral or helical form or profile that can withstand twisting, rotation, articulation or other deformation. For instance, the biasing member **150** is formed to deform, such as to twist or rotate when the biasing member **150** is subjected to dynamic movement (e.g., rotation, articulation, pivoting or the like) of the aileron **110**. In other examples, a deformation of the biasing member **150** includes a change or alteration in the profile of areas of the biasing member **150** that is subjected to more or less force. For example, the deformation of the biasing member **150** includes elongation of regions of the biasing member **150** to an elongated elliptical profile from an original profile of the biasing member **150**.

(19) Proximate to the wingtip **102** is a locking assembly **160**. As illustrated in FIG. 2, the locking assembly **160** is coupled with, for example the aileron **110** or the strut **120** (as illustrated in FIGS. 1 and 3). A lock **165**, for example, retains the aileron **110** in place and can also release the aileron **110**

such that the aileron **110** is able to dynamically move (e.g., rotate, articulate, pivot or the like). For example, the lock **165** is opened or disengaged, or locking components disengage from corresponding locking components associated with the aileron **110** or the strut **120**.

(20) The locking assembly **160** includes, for example, the lock **165** and can include a locking mechanism **164** that is operatively coupled with the lock **165**. The locking mechanism **164** is, for example housed within the locking assembly **160**. In examples, the locking mechanism **164** is designed to transition the lock **165** from a locked configuration to a released configuration. For example, in the locked configuration, the lock **165** includes components that engage with corresponding lock components of the aileron **110** or the strut **120**. In another example, in the released configuration, the locking mechanism **164** opens, or unlocks, the lock **165** from the aileron **110** or the strut **120**.

(21) In an example, the locking assembly **160** includes an accelerometer **166** or other system or component that can be used to detect, sense or measure the velocity, acceleration or deceleration of the aircraft. The accelerometer **166** is in communication with the locking mechanism **164**. For instance, when a specified or a threshold acceleration is measured, detected or sensed by the accelerometer **166**, the accelerometer **166** communicates with the locking mechanism **164**. In examples, the accelerometer **166** is coupled with a controls system that detects gravitational forces according to the acceleration. The locking mechanism **164**, upon receiving a signal from the accelerometer **166**, transitions the lock **165** to open, or disengage.

(22) Illustrated in FIG. **3** is an exploded view of the components of the tailored aileron deployment system assembly. For example, beginning with the area proximate to the wingtip **102**, the locking assembly **160** is positioned proximate to the wingtip **102** such that the accelerometer **166** housed within the locking assembly **160** can measure, detect or sense the acceleration or gravitational forces of the aircraft. Optionally, the accelerometer **166** is positioned in another location of the wing **101** but remains in communication with the locking mechanism **164**. The lock **165** is in cooperatively engagement with a corresponding locking component **168** on a wingtip side **118** of the aileron **110**.

(23) The aileron **110** is coupled with the wing **101** proximate to the wingtip **102**. For example, the aileron **110** is hinged or otherwise coupled with a trailing portion **104** of the wing **101**. The aileron **110** is coupled with the wing **101** in a manner that allows the aileron **110** to rotate, pivot or take an angular configuration relative to the wing **101**. For example, the strut **120** rotationally couples the aileron **110** to internal structures of the wing **101**. The strut **120**, hinge or the like is, for example, positioned internal to the structure of the wing **101** such as within a spar channel.

(24) In an example, the biasing member **150** extends through the internal structure of the wing **101** and is, for example, in rotational engagement with the strut **120** or the aileron **110**. For instance, the second portion **155** of the biasing member **150** retained with the strut **120** or the aileron **110**. In examples, the second portion **155** is coupled with the strut **120** or the aileron **110** to transfer a rotation of the aileron **110** to the biasing member **150**. The biasing member **150** is retained with, for example, one or more braces **140**. The one or more braces **140** are optionally coupled with a portion of a frame of the wing **101**. For example, the one or more braces **140** is coupled with a spar **145** extending through the wing **101**. In an example, the one or more braces **140** are laterally spaced along a portion of the frame of the wing **101** or along the spar **145**.

(25) The biasing member **150** has a profile or form that fits within each of the one or more braces **140**. For example, the one or more braces **140** has a profile that retains the biasing member **150** and allows for the biasing member **150** to deflect or change profile according to twisting, rotation or deformation of the biasing member **150**.

(26) The biasing member **150** is optionally retained proximate to the root **103** of the wing **101**. The root end **151** is optionally formed to be static when the biasing member **150** twists, rotates or deforms. The biasing member **150** is deformable or rotatable along the length while being retained at the root end **151**.

(27) FIG. 4A illustrates one of the one or more braces **140** and FIG. 4B illustrates an exploded view of one of the one or more braces **140**. In an example, the one or more braces **140** included a layered internal recess **141**. The layered internal recess **141** includes a passage that is sized to hold or retain at least a portion of the biasing member **150** as the biasing member **150** extends through the wing **101** (as illustrated in FIGS. 1 and 3). In an example, the layered internal recess **141** includes spacing that allows for deformation of the **150**. Moving from an outermost layer inward, there is for example, a bearing **142**, an internal ring **143** and a deformable insert **144**.

(28) Optionally, the bearing **142** is coupled to an interior surface **140a** of the one or more braces that retain the bearing **142**. The bearing **142** is, for example, designed to facilitate rotation of the biasing member **150** during deformation or rotation of the biasing member **150**. For example, the bearing **142** facilitates rotation by minimizing friction of the biasing member **150** against the interior surface **140a** of the one or more braces **140**. The bearing **142** works in cooperation with the deformable insert **144**.

(29) As illustrated in FIGS. 5A and 5B, the deformable insert **144** includes, for example an air pocket positioned between the internal ring **143** and the deformable insert **144**. In examples, the deformable insert **144** is formed of a material that is deformable in response to changes or alterations in the profile or form of the biasing member **150** such as due to rotation or the like of the biasing member **150**. In the example illustrated in FIG. 5A, the biasing member **150** is in a neutral or nondeformed orientation. The example illustrated in FIG. 5A, the deformable insert **144** is approximately evenly spaced throughout the interior of the deformable insert. For example, the distance of the deformable insert **144** between the biasing member **150** and the bearing **142** is approximately the same.

(30) In the example illustrated in FIG. 5B, the deformable insert **144** works in cooperation with the bearing **142** to allow the biasing member **150** to rotate freely while maintaining a secure connection. As illustrated in FIG. 5B, the deformable insert **144**, for example, changes its cross section to rotatably retain the biasing member **150**, while also maintaining freedom of movement of the biasing member **150**. For example, the distance between one point of the biasing member **150** and the bearing **142** is different than a second location.

(31) Illustrated in FIG. 6 is an example of dynamic movement of the aileron **110**. In an example, the dynamic movement of the aileron **110** includes rotating, deflecting, pivoting or the like the aileron **110** upward. For example, the aileron **110** moves in response to loads, forces or pressure applied to the wing **101**. In an example, the aileron **110** moves from a stowed position, without the aileron **110** locked in position, to a rotated or deflected position.

(32) In an example, the aileron **110** is retained in a stowed position, as illustrated in the orientation of the aileron **110** in FIG. 1. The stowed position includes, for example, the aileron **110** extending approximately continuously from the trailing portion **104** of the wing **101**. In an example, the aileron **110** is statically retained to extend approximately continuously from the trailing portion **104** of the wing **101**. For example, the biasing member **150** in cooperation with the aspect 11 is preloaded according to the aerodynamic design of the aircraft. For instance, the preload and a rotational stiffness are specific to the wing **101**. The preload allows the aileron **110** to return to a stowed configuration when threshold forces are not applied to the wing **101**.

(33) The aileron **110** remains in the stowed configuration until, for example, the accelerometer **166**, as discussed related to FIG. 2, detects, senses or measures a threshold acceleration or force. For example, during a high G rotational turn centrifugal forces the forces recognized or detected by the accelerometer **166** exceed 4 G's. This detection is communicated via a control system within the accelerometer to send a signal to unlock the locking mechanism **164**. In examples, a sharp banking maneuver will put those loads on the aircraft. In other examples, during a high velocity maneuver the aircraft optionally travels at velocities where the accelerometer detects forces approximately three Earth gravitational units (3g's) to approximately seven Earth gravitational units (7g's). In an example, when the accelerometer **166** detects a threshold velocity greater than or equal to

approximately 3g's, the transmits a signal to the locking mechanism **164**, as a component of the locking assembly **160**.

(34) The locking mechanism **164** is, for example, operatively coupled with the accelerometer **166**. When the locking mechanism **164** receives a signal from the accelerometer **166** indicating the aircraft is experiencing forces greater than a threshold value, the locking mechanism **164** transitions the lock **165** from a locked configuration (e.g., holding the aileron from in a stowed configuration) to an unlocked configuration.

(35) In the unlocked configuration, for example, the aileron **110** is released or disengaged from the stowed configuration and the aileron **110**. Optionally, the aileron **110** is free to take a dynamic configuration. In a dynamic configuration, the aileron **110** optionally dynamically moves (e.g., rotates, pivots, or articulates) a predetermined angle. For example, the aileron **110** dynamically moves (e.g., rotates, pivots or articulates) approximately between 15 and 30 degrees, as related to the stowed configuration.

(36) In an example, the dynamic movement (e.g., rotation, pivot or articulation) is confined or limited by the biasing member **150**. Optionally, the biasing member has a preloaded torsional stiffness range. In an example, the torsional stiffness controls the dynamic movement of the aileron **110**. In an example, the biasing member **150** has a torsional stiffness tailored to a specified maximum angle for the aileron **110**. In an example, the aileron **110** will dynamically move to offload the forces causing the wing **101** to bend to allow for structural relief.

(37) When the accelerometer does not measure or detect the threshold acceleration or force, the accelerometer **166** optionally transmits a signal to the locking mechanism **164**. For example, the locking mechanism **164** transitions the lock **165** from an unlocked configuration to a locked configuration. In an example, the lock **165** re-engages the corresponding locking component **168** (as illustrated in FIG. 3). In examples, when the lock **165** re-engages the corresponding locking component **168**, the lock **165** and the corresponding locking component **168** are locked or retained together.

(38) In examples, when the lock **165** and the corresponding locking component **168** are locked together, the aileron **110** is retained in an original orientation or position. For example, the torsional stiffness of the biasing member **150** brings the aileron **110** to the original orientation or position so the locking assembly **160** provides a locking engagement of the aileron **110** relative to the wing **101**. Aspect 1 can include subject matter such as a tailored aileron deployment system assembly including: a locking assembly configured for coupling with an aileron of an aircraft, the locking assembly includes a lock configured for coupling with the aileron; an accelerometer configured to measure acceleration of the aircraft and detect gravitational forces; a lock mechanism operatively coupled with the lock and in communication with the accelerometer, wherein the lock mechanism is configured to transition the lock from a locked configuration to a released configuration; in the locked configuration, the lock retains the aileron in a static configuration; and in the released configuration, the lock mechanism opens the lock based on a specified acceleration measured with the accelerometer, and the lock frees the aileron to a dynamic configuration; and a biasing member coupled with the aileron, in the released configuration the biasing member controls movement of the aileron in the dynamic configuration. Aspect 2 can include, or can optionally be combined with the subject matter of Aspect 1, to optionally include the biasing member is coupled between a wing and the aileron. Aspect 3 can include, or can optionally be combined with the subject matter of one or any combination of Aspects 1 or 2 to optionally include the biasing member includes a torsion spring, the biasing member extending from proximate to a fuselage to a fuselage facing portion of the aileron. Aspect 4 can include, or can optionally be combined with the subject matter of one or any combination of Aspects 1 to 3 to optionally include the biasing member is retained within one or more fittings, the one or more fittings coupled to within an aircraft wing; wherein the one or more fittings are configured to permit deformation of the biasing member. Aspect 5 can include, or can optionally be combined with the subject matter of one or any combination of Aspects 1 to 4 to

optionally include a tailored aileron deployment system assembly including the aileron. Aspect 6 can include, or can optionally be combined with the subject matter of one or any combination of Aspects 1 to 5 to optionally include the aileron includes an outboard aileron; wherein the lock mechanism is configured to transition the lock to the released configuration when the accelerometer detects a threshold gravitational force, the threshold gravitational force includes at least three gravitational forces, relative to earth gravitational forces. Aspect 7 can include, or can optionally be combined with the subject matter of one or any combination of Aspects 1 to 6 to optionally include the lock mechanism is configured to transition the lock to the released configuration when the accelerometer measures a specified acceleration. Aspect 8 can include, or can optionally be combined with the subject matter of one or any combination of Aspects 1-7 to optionally include a rotational strut supporting the aileron, the rotational strut coupled with the lock mechanism on a first side of the rotational strut and the biasing member on a second side of the rotational strut; wherein the lock mechanism is configured to statically retain the rotational strut when the lock is in the locked configuration. Aspect 8 can include subject matter such as a tailored aileron deployment system including: an aileron coupled with a trailing edge of a wing on an aircraft; the aileron having a stowed configuration and a rotation configuration; wherein in the stowed configuration the aileron continuously extends from the trailing edge of the aircraft wing and the aileron is statically retained; wherein in the rotation configuration, the aileron configured to move relative to the trailing edge of the aircraft wing; a locking assembly in communication with the aileron, a locking mechanism positioned proximate to a wing tip of the aircraft wing, the locking assembly including: a lock having a locked configuration and a released configuration; wherein in the locked configuration, the lock is configured to engage and retain the aileron in the stowed configuration; wherein in the released configuration the lock is disengaged from the aileron and the aileron enters the rotation configuration; a biasing member coupled with the aileron, the biasing member configured to control movement of the aileron in the released configuration; and an accelerometer configured to measure an acceleration of the aircraft. Aspect 10 can include, or can optionally be combined with the subject matter of one or any combination of Aspect 9 to optionally include the accelerometer is in communication with a locking mechanism; wherein the locking mechanism is configured to transition the lock to the released configuration when the accelerometer measures a threshold acceleration. Aspect 11 can include, or can optionally be combined with the subject matter of one or any combination of Aspects 8-10 to optionally include a tailored aileron deployment system, including the aileron; wherein the aileron is an outboard aileron. Aspect 12 can include, or can optionally be combined with the subject matter of one or any combination of Aspects 8-10 to optionally include a tailored aileron deployment system, wherein the biasing member is coupled to at least a portion of the aircraft wing. Aspect 13 can include, or can optionally be combined with the subject matter of one or any combination of Aspects 8-12 to optionally include one or more braces laterally spaced along a spar of the aircraft wing, the one or more braces retains the biasing member, the one or more braces including: a bearing coupled to an interior surface of the one or more braces; and a deformable insert coupled to the bearing; wherein the deformable insert is configured to deform in response to a deformation of the biasing member. Aspect 14 can include, or can optionally be combined with the subject matter of one or any combination of Aspects 8-13 to optionally include the biasing member is a torsion spring formed from a composite material. Aspect 15 can include, or can optionally be combined with the subject matter of one or any combination of Aspects 8-14 to optionally include a strut extending between the biasing member and the locking mechanism, the strut including: a reciprocal lock engagement configured to receive the lock when in the stowed configuration; wherein the aileron is coupled with the strut. Aspect 16 can include subject matter such as a method for controlling movement of an aileron, the method including: retaining the aileron in a stowed position with a locking mechanism, the locking mechanism operatively coupled with the aileron; wherein in the stowed position the aileron extends continuously from a trailing end of an aircraft wing and the aileron is

statically retained; measuring acceleration with an accelerometer; wherein the accelerometer is operatively coupled with the locking mechanism; wherein the accelerometer detects gravitational forces; transitioning the locking mechanism from a locked configuration to an unlocked configuration when the accelerometer detects a gravitational force at least equal to a threshold gravitational force; releasing the aileron from the stowed position to a released position when the locking mechanism is in the unlocked configuration; wherein in the released position the aileron moves according to applied forces; and controlling the movement of the aileron with a biasing member coupled with the aileron, the biasing member extending from a position proximate to a fuselage to the aileron. Aspect 17 can include, or can optionally be combined with the subject matter of one or any combination of Aspect 16 to optionally include the threshold gravitational force is at least three gravitational forces, relative to Earth gravitational forces. Aspect 18 can include, or can optionally be combined with the subject matter of one or any combination of Aspects 16-17 to optionally include moving the aileron includes one or rotating or pivoting the aileron relative to the aircraft wing, the method including: rotating the aileron to offload the aircraft wing. Aspect 19 can include, or can optionally be combined with the subject matter of one or any combination of Aspects 16-18 to optionally include deforming the biasing member in response to the position of the aileron when the aileron is in the released position. Aspect 20 can include, or can optionally be combined with the subject matter of one or any combination of Aspects 16-19 to optionally include returning the aileron to the stowed position when the gravitational force is below three gravitational forces.

(39) The above description includes references to the accompanying drawings, which form a part of the detailed description. The drawings show, by way of illustration, specific embodiments in which the invention can be practiced. These embodiments are also referred to herein as “aspects” or “examples.” Such aspects or example can include elements in addition to those shown or described. However, the present inventors also contemplate aspects or examples in which only those elements shown or described are provided. Moreover, the present inventors also contemplate aspects or examples using any combination or permutation of those elements shown or described (or one or more features thereof), either with respect to a particular aspects or examples (or one or more features thereof), or with respect to other Aspects (or one or more features thereof) shown or described herein.

(40) In the event of inconsistent usages between this document and any documents so incorporated by reference, the usage in this document controls.

(41) In this document, the terms “a” or “an” are used, as is common in patent documents, to include one or more than one, independent of any other instances or usages of “at least one” or “one or more.” In this document, the term “or” is used to refer to a nonexclusive or, such that “A or B” includes “A but not B,” “B but not A,” and “A and B,” unless otherwise indicated. In this document, the terms “including” and “in which” are used as the plain-English equivalents of the respective terms “comprising” and “wherein.” Also, in the following claims, the terms “including” and “comprising” are open-ended, that is, a system, device, article, composition, formulation, or process that includes elements in addition to those listed after such a term in a claim are still deemed to fall within the scope of that claim. Moreover, in the following claims, the terms “first,” “second,” and “third,” etc. are used merely as labels, and are not intended to impose numerical requirements on their objects.

(42) Geometric terms, such as “parallel”, “perpendicular”, “round”, or “square”, are not intended to require absolute mathematical precision, unless the context indicates otherwise. Instead, such geometric terms allow for variations due to manufacturing or equivalent functions. For example, if an element is described as “round” or “generally round,” a component that is not precisely circular (e.g., one that is slightly oblong or is a many-sided polygon) is still encompassed by this description.

(43) The above description is intended to be illustrative, and not restrictive. For example, the

above-described aspects or examples (or one or more aspects thereof) may be used in combination with each other. Other embodiments can be used, such as by one of ordinary skill in the art upon reviewing the above description. The Abstract is provided to comply with 37 C.F.R. § 1.72(b), to allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. Also, in the above Detailed Description, various features may be grouped together to streamline the disclosure. This should not be interpreted as intending that an unclaimed disclosed feature is essential to any claim. Rather, inventive subject matter may lie in less than all features of a particular disclosed embodiment. Thus, the following claims are hereby incorporated into the Detailed Description as aspects, examples or embodiments, with each claim standing on its own as a separate embodiment, and it is contemplated that such embodiments can be combined with each other in various combinations or permutations. The scope of the invention should be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled.

Claims

1. A tailored aileron deployment system assembly comprising: a locking assembly configured for coupling with an aileron of an aircraft, the locking assembly includes a lock configured for coupling with the aileron; an accelerometer configured to measure acceleration of the aircraft and detect gravitational forces; a lock mechanism operatively coupled with the lock and in communication with the accelerometer, wherein the lock mechanism is configured to transition the lock from a locked configuration to a released configuration; in the locked configuration, the lock retains the aileron in a static configuration; and in the released configuration, the lock mechanism opens the lock based on a specified acceleration measured with the accelerometer, and the lock frees the aileron to a dynamic configuration; and a biasing member coupled with the aileron, in the released configuration the biasing member controls movement of the aileron in the dynamic configuration.
2. The tailored aileron deployment system assembly of claim 1, wherein the biasing member is coupled between a wing and the aileron.
3. The tailored aileron deployment system assembly of claim 1, wherein the biasing member includes a torsion spring, the biasing member extending from proximate to a fuselage to a fuselage facing portion of the aileron.
4. The tailored aileron deployment system assembly of claim 3, wherein the biasing member is retained within one or more fittings, the one or more fittings coupled to within an aircraft wing; wherein the one or more fittings are configured to permit deformation of the biasing member.
5. The tailored aileron deployment system assembly of claim 1 comprising the aileron.
6. The tailored aileron deployment system assembly of claim 5, wherein the aileron includes an outboard aileron; wherein the lock mechanism is configured to transition the lock to the released configuration when the accelerometer detects a threshold gravitational force, the threshold gravitational force includes at least three gravitational forces, relative to earth gravitational forces.
7. The tailored aileron deployment system assembly of claim 1, wherein the lock mechanism is configured to transition the lock to the released configuration when the accelerometer measures a specified acceleration.
8. The tailored aileron deployment system assembly of claim 1, including: a rotational strut supporting the aileron, the rotational strut coupled with the lock mechanism on a first side of the rotational strut and the biasing member on a second side of the rotational strut; wherein the lock mechanism is configured to statically retain the rotational strut when the lock is in the locked configuration.
9. A tailored aileron deployment system comprising: an aileron coupled with a trailing edge of a

wing on an aircraft; the aileron having a stowed configuration and a rotation configuration; wherein in the stowed configuration the aileron continuously extends from the trailing edge of the aircraft wing and the aileron is statically retained; wherein in the rotation configuration, the aileron configured to move relative to the trailing edge of the aircraft wing; a locking assembly in communication with the aileron, a locking mechanism positioned proximate to a wing tip of the aircraft wing, the locking assembly including: a lock having a locked configuration and a released configuration; wherein in the locked configuration, the lock is configured to engage and retain the aileron in the stowed configuration; wherein in the released configuration the lock is disengaged from the aileron and the aileron enters the rotation configuration; a biasing member coupled with the aileron, the biasing member configured to control movement of the aileron in the released configuration; and an accelerometer configured to measure an acceleration of the aircraft.

10. The tailored aileron deployment system of claim 9, wherein the accelerometer is in communication with a locking mechanism; wherein the locking mechanism is configured to transition the lock to the released configuration when the accelerometer measures a threshold acceleration.

11. The tailored aileron deployment system of claim 9, comprising the aileron; wherein the aileron is an outboard aileron.

12. The tailored aileron deployment system of claim 9, wherein the biasing member is coupled to at least a portion of the aircraft wing.

13. The tailored aileron deployment system of claim 9, including: one or more braces laterally spaced along a spar of the aircraft wing, the one or more braces retains the biasing member, the one or more braces including: a bearing coupled to an interior surface of the one or more braces; and a deformable insert coupled to the bearing; wherein the deformable insert is configured to deform in response to a deformation of the biasing member.

14. The tailored aileron deployment system of claim 9, wherein the biasing member is a torsion spring formed from a composite material.

15. The tailored aileron deployment system of claim 9, including: a strut extending between the biasing member and the locking mechanism, the strut including: a reciprocal lock engagement configured to receive the lock when in the stowed configuration; wherein the aileron is coupled with the strut.

16. A method for controlling movement of an aileron, the method comprising: retaining the aileron in a stowed position with a locking mechanism, the locking mechanism operatively coupled with the aileron; wherein in the stowed position the aileron extends continuously from a trailing end of an aircraft wing and the aileron is statically retained; measuring acceleration with an accelerometer; wherein the accelerometer is operatively coupled with the locking mechanism; wherein the accelerometer detects gravitational forces; transitioning the locking mechanism from a locked configuration to an unlocked configuration when the accelerometer detects a gravitational force at least equal to a threshold gravitational force; releasing the aileron from the stowed position to a released position when the locking mechanism is in the unlocked configuration; wherein in the released position the aileron moves according to applied forces; and controlling the movement of the aileron with a biasing member coupled with the aileron, the biasing member extending from a position proximate to a fuselage to the aileron.

17. The method for controlling the movement of claim 16, wherein the threshold gravitational force is at least three gravitational forces, relative to Earth gravitational forces.

18. The method for controlling the movement of claim 16, wherein moving the aileron includes one or rotating or pivoting the aileron relative to the aircraft wing, the method including: rotating the aileron to offload the aircraft wing.

19. The method for controlling the movement of claim 16, including: deforming the biasing member in response to the position of the aileron when the aileron is in the released position.

20. The method for controlling the movement of claim 16, including: returning the aileron to the stowed position when the gravitational force is below three gravitational forces.
