

A Wing Joint For An Aircraft

Field of the Invention

The present invention relates broadly an aircraft having a wing joint structure, and to a landing method for an aircraft.

Background

Unmanned aerial vehicles (UAV) are used in military and commercial applications, e.g. for exploring unknown territories. A 5-10 kg class of military UAVs is widely used by armed forces as soldiers can easily carry it to an area of conflict in order to provide reconnaissance. These UAVs are usually operated from a forest zone, which requires launching and recovery of the UAVs within limited open areas in the forest. Due to limitations on the weight of the aircraft and the availability of limited landing space, it is difficult to land an UAV without any structural damage to the UAV.

UAVs used in military service, usually employ a parachute or an airbag or a combination of a parachute and an airbag for landing purposes. However, due to limitations in storage space on the UAV and because the effect of wind on the UAV is large, only a small parachute is commonly used, which results in a descent rate of up to 10m/s during recovery of the aircraft. This results in rather high shock levels on the entire aircraft upon impact.

Presently used UAVs employ segmented wings in which the outer wings of an aircraft usually experience tremendous downward whiplash loads during landing, which may result in damage to the wings and its joints.

Reinforcing the joints of the segmented wings of an aircraft is not practicable because minimizing weight is critical to an UAV. Alternatively, breakable wings may be employed to create a deliberate physical breakage of a wing along an anticipated break line to dissipate energy upon landing. However, the nature of such breakage is in practice highly unpredictable and often such physical breakages result in an irreparable additional damage to the wing, which in turn may result in grounding of the aircraft.

Accordingly, there is a need to provide a wing joint, which seeks to address one or more of the above problems.

Summary of the Invention

In accordance with a first aspect of the present invention there is provided an aircraft comprising a fuselage; respective inner wing portions connected to either side of the fuselage; and at least one outer wing portion connected to each inner wing portion; wherein opposing surfaces of the inner and outer wing portions are attached to each other by respective wing joint structures, and wherein the wing joint structures are arranged to move from a closed position into an open position allowing the outer wing portions to move relative to the inner wing portions when the outer wing portions encounter a downward force caused by the aircraft landing on a surface .

The outer wing portions may be operable to lock on to the inner wing portions during flight due to upwardly acting aerodynamic forces.

The opposing surfaces of the inner and outer wing portions may comprise end caps, which are bonded to the skin and the spar of the wings.

The wing joint structures may each comprise a pair of opposing velcro tapes or other means of releasable attachment that are attached to the opposing end caps of the inner and the outer wing portions.

The end cap of each of the outer wing portion may comprise one or more lugs .

The end cap of each of the inner wings may comprise one or more depressions , wherein the depressions cooperably mate with the opposing lugs.

The aircraft may further comprise a hinge structure fixed to the under surfaces of the inner wing and the outer wing portions.

The hinge structure may comprise a material made of canvas, or plastic.

The aircraft may further comprise a parachute and/or airbag that are mounted to the fuselage and deployed before landing the aircraft.

Landing of the aircraft and the deployment of the parachute and/or airbag may be automated or remotely controlled.

The aircraft may be an unmanned aerial vehicle (UAV).

In accordance with a second aspect of the present invention there is provided a landing method for an aircraft comprising the steps of connecting an inner wing portion and at least one outer wing portion on either side of a fuselage; attaching the opposing surfaces of the inner and outer wing portions via a wing joint structure; and arranging the wing joint structures to move from a closed position into an open position allowing the outer wing portions to move relative to the inner wing portions when the outer wing portions encounter a downward force caused by the aircraft landing on a surface.

Brief Description of the Drawings

The present invention is further described by way of non-limiting embodiments, with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram of an aircraft (in a landing position) having a wing joint in accordance with an embodiment of the present invention; and

Figure 2 is a partial cross-sectional view of the wing joint of the aircraft of Figure 1.

Description

Embodiments of the present invention provide a light and non-breaking joint to the wings of an aircraft used as an unmanned aerial vehicle (UAV).

Figure 1 is a schematic diagram of an aircraft 100 in a landing position having a wing joint 113 in accordance with an embodiment of the present invention. The aircraft 100 is seen above a landing surface 101 with an air bag 111 in an open position, below the fuselage 107.

In the embodiment, the aircraft 100 comprises a fuselage 107, two inner wings 105a, 105b and two outer wings 103a, 103b. The two outer wings 103a, 103b are removably mounted on respective ends of the inner wings 105a, 105b. A pair of joints 113 connect the two outer wings 103a, 103b to the inner wings 105a, 105b.

In order to illustrate the functioning of the joints 113, the aircraft 100 is considered in two halves 180 and 190 that are symmetrical. A first half 180 illustrates the forces acting on the aircraft 100 upon impacting the ground 101 and a second half 190 illustrates the forces acting on the aircraft 100 on flight. A pair of flexible hinges 115 attaches each of the outer wings 103a, 103b to the inner wings 105a, 105b, from the bottom.

The joints 113 are so designed to enable the outer wings 103a, 103b to remain locked to the inner wings 105a, 105b during flight, due to an upwardly acting locking moment 150 arising from the upwardly acting aerodynamic forces 170 on the outer wing 103b. Upon
 5 impacting the ground 101, an airbag 111 absorbs the G forces 130 caused by the weight of the aircraft along the fuselage 107. An impact force 120 caused on impact of the fuselage 107 on the ground causes an upwardly acting impact force 120 on the fuselage 107, which in turn causes a downwardly acting force 160 acting on the wing 103a causing a disengaging moment 140 of the joint 113, thereby releasing the outer wing 103 to gently
 10 impact the ground 101. In essence, the two joints 113 move from a "closed" position into an "open" position in a controlled manner upon impact of the fuselage 107 on the ground 101 and dissipate energy thereby advantageously preventing structural damage to the wing structure. This allows the outer wing portions to move relative to the inner wing portions when the outer wing portions encounter a downward moment caused by the
 15 aircraft landing on a surface.

In operation, embodiments of the aircraft 100 employs a combination of a parachute (not shown) and the air bag 111 for landing. The instants at which the parachute and airbag 111 are to be opened are controlled remotely by an operator or onboard flight computer
 20 maneuvering the aircraft 100. Before landing, the aircraft 100 is stalled or slowed above a landing zone and the parachute deployed either by an operator or automatically by the onboard computer, which slows down the descent of aircraft 100, above the landing zone, and thereafter, the airbag 111 is deployed to cushion the landing on the landing surface
 25 101.

Figure 2 is a partial cross-sectional view of the wing joint 113 of the aircraft 100 of Figure 1. The wing joint 113 is made between the inner wing 105a, 105b and the outer wing 103a, 103b. A means of releasable attachment like clips or Velcro tapes 201, 203 are respectively attached to the two opposing surfaces of the inner wing 105a, 105b and the
 30 outer wing 103a, 103b. A hinge 115 made of e.g. canvas or plastic is fixed to the under surfaces of the inner wing 105 and the outer wings 103a, 103b.

Each of the two opposing surfaces of the inner wing 105a, 105b and the outer wing 103a, 103b have end caps 202, 204, which are bonded to the skin and the spar of the wings
 35 105, 103a, 103b to form a stable platform for the hinge 115. Each of the end caps 202, 204 has a straight portion along the bottom surface of the wings 105a, 105b, 103a, 103b for accommodating the hinge 115, which are hidden from view in Figure 2. A pair of conical

lugs 205a, 205b are positioned on the face of the end cap 204 corresponding to the outer wing 103a, 103b, one on either side of the Velcro tape 203. The two conical lugs 205a, 205b cooperably mate with corresponding conical depressions 207a, 207b located on either side of the velcro tape 201 of the other end cap 202 to cater for vertical loads experienced at the joints during flight.

During flight of the aircraft 100, the upwardly acting aerodynamic forces 170 lock the outer wing 103a, 103b against the respective inner wing 105a, 105b along the hinge 115 and through the contact of respective end caps 202, 204 of the wings 105a, 105b, 103a, 103b.

The conical lugs 205a, 205b advantageously not only help in preventing vertical movements of the wings 105a, 105b, 103a, 103b, but also relieve stress on the hinges 115. Velcro tapes 201, 203 help in preventing the outer wing 103a, 103b from disengagement during flight or when there is a momentary loss of lift on the outer wing 103a, 103b.

A landing method for an aircraft according to an example embodiment comprises the steps of connecting an inner wing portion and at least one outer wing portion on either side of a fuselage; attaching the opposing surfaces of the inner and outer wing portions via a wing joint structure; and arranging the wing joint structures to move from a closed position into an open position allowing the outer wing portions to move relative to the inner wing portions when the outer wing portions encounter a downward force caused by the aircraft landing on a surface.

The invention is not limited to the above embodiments. However, those skilled in the art will recognize that the invention can be practiced, with modification, in the light of the information contained herein without departing from the scope of the invention.

For example, there can be more than one outer wing portions on each side of the aircraft, each additional outer wing portion being connected to it's adjacent wing portion using another wing joint structure.

Claims:

1. An aircraft comprising:

a fuselage;

respective inner wing portions connected to either side of the fuselage; and

at least one outer wing portion connected to each inner wing portion;

wherein opposing surfaces of the inner and outer wing portions are attached to each other by respective wing joint structures, and

wherein the wing joint structures are arranged to move from a closed position into an open position allowing the outer wing portions to move relative to the inner wing

portions when the outer wing portions encounter a downward force caused by the aircraft landing on a surface .

2. The aircraft of claim 1, wherein the outer wing portions are operable to lock on to the inner wing portions during flight due to upwardly acting aerodynamic forces.

3. The aircraft of claim 1 or 2, wherein the opposing surfaces of the inner and outer wing portions comprise end caps, which are bonded to the skin and the spar of the wings.

4. The aircraft of any one of claim 1, 2 or 3, wherein each the wing joint structure comprises a pair of opposing velcro tapes or other means of releasable attachment that are attached to the opposing end caps of the inner and the outer wing portions.

5. The aircraft according to any one of the preceding claims, wherein the end cap of each of the outer wing portion comprises one or more lugs .

6. The aircraft according to claim 5, wherein the end cap of each of the inner wings comprises one or more depressions , wherein the depressions cooperably mate with the opposing lugs.

7. The aircraft according to any one of the preceding claims, further comprising a hinge structure fixed to the under surfaces of the inner wing and the outer wing portions.

8. The aircraft according to claim 7, wherein the hinge structure comprises a material made of canvas, or plastic.

9. The aircraft according to any one of the preceding claims, further comprising a parachute and/or airbag that are mounted to the fuselage and deployed before landing the aircraft.

5 10. The aircraft according to any one of the preceding claims, wherein landing of the aircraft and the deployment of the parachute and/or airbag are automated or remotely controlled.

11. The aircraft according to any one of the preceding claims, wherein the aircraft is an
10 unmanned aerial vehicle (UAV).

12. A landing method for an aircraft comprising the steps of :
connecting an inner wing portion and at least one outer wing portion on either side
of a fuselage;

15 attaching the opposing surfaces of the inner and outer wing portions via a wing joint structure; and

arranging the wing joint structures to move from a closed position into an open
position allowing the outer wing portions to move relative to the inner wing portions when
the outer wing portions encounter a downward force caused by the aircraft landing on a
20 surface.