SUMMARY

[0006] Embodiments described herein relate to unmanned aerial vehicles (UAV) rotor units having stacked rotor blades. The stacked rotor blades are formed from blade elements that are arranged in a stacked configuration. The blade elements can be easily manufactured from simple machining processes, such as laser cutting the blade elements from a fiber sheet material. Furthermore, arranging the blade elements in a stacked configuration allows for a high degree of control over the overall design and function of the assembled stacked rotor blades. Moreover, the stacked rotor blades disclosed herein may also reduce the noise of UAV rotors during flight while maintaining or possibly increasing efficiency as compared to existing rotor blade designs.

[0006a] According to a first aspect of the present invention, there is provided a rotor unit comprising:

a hub that is configured to rotate about an axis in a first rotational direction; and

a stacked rotor blade fixed to the hub such that the stacked rotor blade is rotatable about the axis, the stacked rotor blade comprising:

a first blade element comprising a first leading edge and a first alignment feature, and

a second blade element comprising a second leading edge and a second alignment feature,

wherein the first blade element and the second blade element are arranged in a stacked configuration,

wherein the first alignment feature of the first blade element couples to the second alignment feature of the second blade element, and

wherein at least a portion of the first leading edge and at least a portion of the second leading edge form a leading edge of the stacked rotor blade.

[0006b] According to a second aspect of the present invention, there is provided a stacked rotor blade comprising:

a first planar blade element comprising a first leading edge and a bottom planar surface, and

a second planar blade element comprising a second leading edge and a top planar surface;

wherein the bottom planar surface of the first planar blade element is directly fixed to the top planar surface of the second planar blade element in a stacked configuration,

wherein the stacked rotor blade is configured to rotate in a first rotation direction,

wherein at least a portion of the first leading edge leads the second leading edge in the first rotation direction, and

wherein at least a portion of the first leading edge and at least a portion of the second leading edge form a leading edge of the stacked rotor blade.

[0006c] According to a third aspect of the present invention, there is provided a method comprising:

cutting a plurality of blade elements, wherein at least one dimension of each of the plurality of blade elements is different than a corresponding dimension of each other blade element of the plurality of blade elements;

aligning and directly fixing each of the plurality of cut blade elements to form a stacked blade, wherein the alignment of the plurality of cut blade elements further defines a profile of the stacked blade, and wherein a leading edge of the stacked blade comprises at least a portion of a leading edge from each of the plurality of cut blade elements; and

coupling the stacked blade to a hub.

[0007] Further, a rotor unit is provided. The rotor unit includes a hub and a stacked rotor blade. The hub is configured to rotate about an axis in a first rotation direction. The stacked rotor blade is rotatable about the axis and further includes a first blade element and a second blade element. The first blade element has a first leading edge and the second blade element has a second leading edge. Moreover, the first blade element and the second blade element are arranged in a stacked configuration. Within examples, the stacked configuration may result in the first blade element and the second blade element being fixed to one another with a specific alignment. Additionally, a leading edge of the stacked rotor blade is formed from at least a portion of the first leading edge and at least a portion of the second leading edge. In some embodiments, the rotor unit is coupled to a UAV.

[0008] Further, a stacked rotor blade is provided. The stacked rotor blade includes a first planar blade element and a second planar blade element. The first blade element includes a first leading edge and a bottom planar surface while the second blade element includes a second leading edge and a top planar surface. The bottom planar surface of the first blade element is fixed to the top planar surface of the second blade element in a stacked configuration. The stacked rotor blade is configured to rotate in a first rotation direction. Moreover, at least a portion of the first leading edge of the first blade element leads at least a portion of the second leading edge of the second blade element in the first rotational direction.

Additionally, at least a portion of the first leading edge and at least a portion of the second leading edge form a leading edge of the stacked rotor blade.

[0009] Further, a method of manufacturing stacked blade rotor units is provided. The method includes cutting a plurality of blade elements. The blade elements may be laser cut from a fiber sheet, among other possibilities. At least one dimension of each of the blade elements is different than a corresponding dimension in each other blade element. Moreover, a

leading edge of the stacked blade includes at least a portion of a leading edge from each of the cut blade elements. The method further includes coupling the blade elements to a hub.

[0010] Further, any type of device or system could be used or configured as a means for performing functions of any of the methods described herein (or any portions of the methods described herein). For example, a system to manufacture stacked rotor blade units includes means to cut a plurality of blade elements. The system further includes means to align the blade elements as well as means to couple the blade elements to a hub of a rotor unit.

[0011] These as well as other aspects, advantages, and alternatives will become apparent to those of ordinary skill in the art by reading the following detailed description, with reference where appropriate to the accompanying drawings. Further, it should be understood that the description provided in this summary section and elsewhere in this document is intended to illustrate the claimed subject matter by way of example and not by way of limitation.

CLAIMS

1. A rotor unit comprising:

a hub that is configured to rotate about an axis in a first rotational direction; and

a stacked rotor blade fixed to the hub such that the stacked rotor blade is rotatable about the axis, the stacked rotor blade comprising:

a first blade element comprising a first leading edge and a first alignment feature, and

a second blade element comprising a second leading edge and a second alignment feature,

wherein the first blade element and the second blade element are arranged in a stacked configuration,

wherein the first alignment feature of the first blade element couples to the second alignment feature of the second blade element, and

wherein at least a portion of the first leading edge and at least a portion of the second leading edge form a leading edge of the stacked rotor blade.

2. The rotor unit of claim 1, wherein at a first radial distance from the axis, a chord of the stacked rotor blade is greater than each of a chord of the first blade element and a chord of the second blade element.

3. The rotor unit of claim 1, wherein a span of the stacked rotor blade is greater than a span of the first blade element, and further wherein the span of the stacked rotor blade is greater than a span of the second blade element.

4. The rotor unit of claim 1, wherein the first blade element is radially offset from the second blade element relative to the axis.

5. The rotor unit of claim 1, wherein a tip of the first blade element is radially aligned with the leading edge of the second blade element.

6. The rotor unit of claim 1, wherein the stacked rotor blade further comprises a third blade element and a span of the third blade element is greater than a span of the second blade element, and a length of the second blade element is greater than a span of the first blade element.

7. The rotor unit of claim 1, wherein the first alignment feature is formed within the first blade element, and further wherein the second alignment feature is formed within the second blade element.

8. The rotor unit of claim 1, wherein the first alignment feature comprises a recess, and wherein the second alignment feature comprises a protrusion configured to mate with the recess.

9. The rotor unit of claim 1, wherein the hub comprises a clamping nut that maintains an alignment between the first blade element and the second blade element.

10. The rotor unit of claim 1, wherein the first blade element is constructed from a first material, wherein the second blade element is constructed from a second material, and wherein the first material has a different elasticity than the second material.

11. The rotor unit of claim 1, wherein at least a portion of the leading edge of the first blade element comprises tubercles.

12. The rotor unit of claim 1, wherein an angle of attack of the stacked rotor blade is based on a combination of a first angle of attack of the first blade element and a second angle of attack of the second blade element.

13. The rotor unit of claim 1, wherein the first blade element is planar.

14. The rotor unit of claim 1, wherein the stacked configuration is arranged such that the first blade element is stacked directly on the second blade element.

15. The rotor unit of claim 1, wherein the first alignment feature and the second alignment feature are coupled such that the first blade element is fixed relative to the second blade element.

16. A stacked rotor blade comprising:

a first planar blade element comprising a first leading edge and a bottom planar surface, and

a second planar blade element comprising a second leading edge and a top planar surface;

wherein the bottom planar surface of the first planar blade element is directly fixed to the top planar surface of the second planar blade element in a stacked configuration,

wherein the stacked rotor blade is configured to rotate in a first rotation direction,

wherein at least a portion of the first leading edge leads the second leading edge in the first rotation direction, and

wherein at least a portion of the first leading edge and at least a portion of the second leading edge form a leading edge of the stacked rotor blade.

17. A method comprising:

cutting a plurality of blade elements, wherein at least one dimension of each of the plurality of blade elements is different than a corresponding dimension of each other blade element of the plurality of blade elements;

aligning and directly fixing each of the plurality of cut blade elements to form a stacked blade, wherein the alignment of the plurality of cut blade elements further defines a profile of the stacked blade, and wherein a leading edge of the stacked blade comprises at least a portion of a leading edge from each of the plurality of cut blade elements; and

coupling the stacked blade to a hub.

18. The method of claim 17, wherein aligning each of the plurality of cut blades comprises:

coupling each of the plurality of cut blade elements to another of the plurality of cut blade elements such that each of the plurality of cut blade elements is radially offset relative an axis of rotation from another of the plurality of cut blade elements, wherein the axis of rotation extends vertically through a center of the hub.

19. The method of claim 17, wherein the plurality of blade elements are each cut from a fiber sheet.

20. The stacked rotor blade of claim 16, wherein the bottom planar surface of the first planar blade is adhered to the top planar surface of the second planar blade element in a stacked configuration.