shaped upper portion, which may have an equal spacing therebetween. A side wall of the payload coupling apparatus beneath the hemispherically-shaped upper surface may also be provided with holes, and cams on the side walls also may include holes therein.

[0010] Similarly, the hook or lip of the payload coupling apparatus has holes positioned therein that extend from the slot through the upper and lower surfaces of the hook or lip. In addition, an upper surface of the slot includes one or more holes therein that extend from the slot into an interior of the payload coupling apparatus.

[0011] The holes extend through outer surfaces of the payload coupling apparatus into a hollow interior of the payload coupling apparatus. As a result, air is allowed to flow through the payload coupling apparatus, i.e. through the holes on the hemispherically-shaped upper portion and through the holes in the upper and lower surfaces of the slot and hook or lip, during high speed flight which allows for the payload coupling apparatus to remain in a stable position during retraction as the UAV moves at full cruise speed of 25-35 m/s or more.

[0012] In a first aspect of the present invention, there is provided a payload coupling apparatus that includes a housing having an upper portion, a lower portion, and a side wall positioned between the upper and lower portions, an attachment point on the housing adapted for attachment to a first end of a tether, a slot in the housing that extends downwardly towards a center of the housing thereby forming a hook or lip on the lower portion of the housing beneath the slot, a plurality of holes in the upper portion of the housing; and a plurality of holes in the lower portion of the housing; wherein the housing is hollow, and air is allowed to flow through the plurality of holes in the upper portion of the housing, through the housing, and exit the plurality of holes in the lower portion of the housing.

[0013] In a second aspect of the present invention, there is provided a method of retracting a payload coupling apparatus to a unmanned aerial vehicle is provided including (i) providing the payload coupling apparatus with a housing having an upper portion and a lower portion, and a side wall positioned between the upper portion and the lower portion, the housing attached to a first end of a tether with a second end of the tether attached to the unmanned aerial vehicle, a slot in the housing that extends downwardly towards a center of the housing thereby forming a hook or lip on the lower portion of the housing beneath the slot, a plurality of holes in the upper portion of the housing, a plurality of holes in the side wall of the housing, and a plurality of holes positioned in the lower portion of the housing, wherein the housing is hollow, and air is allowed to flow through the plurality of holes in the upper portion of the housing, through the housing,

and exit the plurality of holes in the lower portion of the housing; (ii) moving the unmanned aerial vehicle forward at a rate of 25-35 m/s; (iii) retracting the payload coupling apparatus towards the unmanned aerial vehicle with the tether as the unmanned aerial vehicle moves forward at a rate of 25-35 m/s; and (iv) wherein the payload coupling apparatus remains stable during retraction of the payload coupling apparatus.

[0014] The present embodiments further provide a system for retracting a payload coupling apparatus with means for providing stable, non-erratic payload coupling apparatus retraction at UAV cruise speed.

CLAIMS

What is claimed is:

1. A payload coupling apparatus comprising:

a housing having an upper portion, a lower portion, and a side wall positioned between the upper and lower portions;

an attachment point on the housing adapted for attachment to a first end of a tether;

a slot in the housing that extends downwardly towards a center of the housing thereby forming a hook or lip on the lower portion of the housing beneath the slot;

a plurality of holes in the upper portion of the housing; and

a plurality of holes in the lower portion of the housing.

wherein the housing is hollow, and air is allowed to flow through the plurality of holes in the upper portion of the housing, through the housing, and exit the plurality of holes in the lower portion of the housing.

2. The payload coupling apparatus of claim 1, wherein a plurality of holes are positioned in the side wall of the housing.

3. The payload coupling apparatus of claim 2, wherein a first cam and a second cam extend outwardly from opposite sides of the side wall, and

wherein a plurality of holes are positioned on the first cam and on the second cam.

4. The payload coupling apparatus of claim 1, wherein the plurality of holes on the lower portion of the housing extend through a bottom surface of the hook or lip.

5. The payload coupling apparatus of claim 4, wherein one or more holes extend through a top surface of the hook or lip.

6. The payload coupling apparatus of claim 5, wherein one or more holes extend through an upper surface of the slot.

7. The payload coupling apparatus of claim 1, wherein the upper portion of the housing has a hemispherical shape.

8. The payload coupling apparatus of claim 1, wherein the plurality of holes on a left side of the upper portion of the housing are positioned symmetrically with the plurality of holes on a right side of the upper portion of the housing.

9. The payload coupling apparatus of claim 2, wherein air is partially directed through the holes in the side wall during flight.

10. The payload coupling apparatus of claim 1, wherein the plurality of holes on a left side of the lower portion of the housing are positioned symmetrically with the plurality of holes on a right side of the lower portion of the housing.

11. The payload coupling apparatus of claim 1, wherein a weighted disc is positioned within the housing.

12. The payload coupling apparatus of clam 11, wherein one or more holes are positioned in the weighted disc.

13. The payload coupling apparatus of claim 11, wherein the weighted disc includes a centrally located aperture.

14. The payload coupling apparatus of claim 12, wherein the housing is hollow, and air is allowed to flow through the plurality of holes in the upper portion of the housing, through the one or more holes in the weighted disc, through the housing, and exit the plurality of holes in the lower portion of the housing.

15. The payload coupling apparatus of claim 2, wherein when the first end of the tether is attached to the attachment point on the housing, the housing remains stable when the housing moves through an air flow of 25-35 m/s.

16. The payload coupling apparatus of claim 2, wherein the side wall has a diameter D, and wherein when the first end of the tether is attached to the attachment point on the housing, the housing has a centerline that remains within a distance of 2D to 3D of centerline of the housing when the housing moves through an air flow of 25-35 m/s.

17. The payload coupling apparatus of claim 3, wherein a first indentation is positioned on a right side of the slot and a second indentation is positioned on a left side of the slot, and the first and second indentations and first and second cams are adapted to prevent a handle of a payload from coming out of the slot during possible rotation of the payload caused by high winds during winch up.

18. A method of retracting a payload coupling apparatus to an unmanned aerial vehicle comprising:

providing the payload coupling apparatus with a housing having an upper portion and a lower portion, and a side wall positioned between the upper portion and the lower portion, the housing attached to a first end of a tether with a second end of the tether attached to the unmanned aerial vehicle, a slot in the housing that extends downwardly towards a center of the housing thereby forming a hook or lip on the lower portion of the housing beneath the slot, a plurality of holes in the upper portion of the housing, a plurality of holes in the side wall of the housing, and a plurality of holes positioned in the lower portion of the housing, wherein the housing is hollow, and air is allowed to flow through the plurality of holes in the upper portion of the housing, through the housing, and exit the plurality of holes in the lower portion of the housing;

moving the unmanned aerial vehicle forward at a rate of 25-35 m/s;

retracting the payload coupling apparatus towards the unmanned aerial vehicle with the tether as the unmanned aerial vehicle moves forward at a rate of 25-35 m/s;

wherein the payload coupling apparatus remains stable during retraction of the payload coupling apparatus.

19. The method of claim 18, wherein the plurality of holes on the lower portion of the housing extend through a bottom surface of the hook or lip;

wherein a plurality of holes extend through a top surface of the hook or lip; and

wherein a plurality of holes extend through an upper surface of the slot.

20. The method of claim 18, wherein a weighted disc is positioned within the housing;

wherein the weighted disc includes one or more holes; and

wherein the housing is hollow, and air is allowed to flow through the plurality of holes in the upper portion of the housing, through the one or more holes in the weighted disc, through the housing, and exit the plurality of holes in the lower portion of the housing.

21. The payload coupling apparatus of claim 1,

wherein a first cam and a second cam extend outwardly from opposite sides of the side wall; and

wherein a first indentation is positioned on a right side of the slot and a second indentation is positioned on a left side of the slot, and the first and second indentations and first and second cams are adapted to prevent a handle of a payload from coming out of the slot during possible rotation of the payload caused by high winds during winch up.