

A FOOT-SECURING ASSEMBLY AND RELATED METHODS

TECHNICAL FIELD

The present disclosure relates broadly to an assembly for securing a foot of a person onto a surface of a watercraft and a watercraft comprising the assembly. Related apparatuses and methods are also disclosed herein.

BACKGROUND

Technological advances in sailing as well as the introduction of faster boat classes in Olympic sailing events have kept the sport exciting and increased spectatorship. However, the faster boat classes are also more unstable and prone to capsize and collisions. Injury surveillance studies conducted at the youth and senior world championships have documented increasing injury rates with the introduction of these faster boats. Particularly high injury rates and more serious injuries were documented for the high performance boats of the 49er, 49er FX and Nacra 17 classes.

Typically, sailors sailing these high performance boats insert their feet into rigid foot straps to anchor themselves to the boats while trapezing (being harnessed to a wire attached to the top of the mast) in an attempt to maximum leverage to achieve high speeds and maneuverability. However, this works against a sailor in times of sudden acceleration or deceleration, for example in times of a collision or a broach, when the body of the sailor is violently flung forward or backward with the feet strapped in. As the body is unsupported and the feet are the only points of the body fixed to the accelerating or decelerating boats, the sailor experiences enormous strain at the ankles and knees, as well as the metatarsal bones of the foot, leading to injuries.

In view of the above, there is thus a need for an assembly and a method for securing a foot of a person onto a surface of a watercraft that address or at least ameliorate one or more of the above problems.

SUMMARY

In one aspect, there is provided an assembly for securing a foot of a person onto a surface of a watercraft, said assembly comprising: a retention member for receiving and securing the foot in a default position; and a rotatable member coupled to the retention member for allowing the retention member to be rotated upon itself and about an axis substantially perpendicular to the surface of the watercraft; wherein the rotatable member is configured to rotate the retention member from the default position to a rotated position when a torque applied to the rotatable member exceeds a threshold.

In one embodiment, the rotatable member comprises a biasing member for biasing the retention member to the default position.

5 In one embodiment, the retention member is configured to secure the received foot such that length of the received foot is substantially perpendicular to a direction of motion of the watercraft in the default position.

10 In one embodiment, the rotated position comprises a position where the retention member is rotated from between more than 0° and 90° from the default position.

15 In one embodiment, the assembly further comprises a stop member configured to prevent a further rotation of the rotatable member, when the rotatable member has rotated to a maximal rotated position.

20 In one embodiment, the stop member comprises a protrusion projecting from a surface of the rotatable member, such that the protrusion moves along a rotational path in tandem with rotation of the rotatable member, and positioning a stopper at a point on the rotational path prevents further rotation of the rotatable member.

In one embodiment, the maximal rotated position comprises a position where retention member is rotated from between 30° and 90° from the default position.

25 In one embodiment, the retention member comprises a midfoot strap.

In one embodiment, the rotatable member comprises a rotary pivot or a rotary bearing.

30 In one embodiment, the biasing member is adjustable to vary the threshold, the rotated position, the maximal rotated position or a biasing strength of the biasing member.

In one embodiment, the biasing member comprises a torsional spring or a linear spring.

35 In one embodiment, the stiffness of the torsional spring is from 100 Nm/rad to 1000 Nm/rad.

40 In one embodiment, the threshold is more than the torque applied to the rotatable member during normal motion condition of the watercraft without sharp deceleration.

In one embodiment, an exposed area of the rotatable member is flush with the surface of the watercraft.

In one embodiment, the retention member is devoid of a power source.

In one embodiment, the rotatable member is configured to be rotatable in the anti-clockwise direction from the default position, when the rotatable member is disposed on the starboard side of the watercraft.

In one embodiment, the rotatable member is configured to be rotatable in the clockwise direction from the default position, when the rotatable member is disposed on the port side of the watercraft.

In one aspect, there is provided an apparatus comprising a pair of first and second assemblies, each of the assemblies in accordance with one or more of above embodiments, wherein the maximal rotated position of the first assembly relative to the default position is at a different angle from the rotated position of the second assembly.

In one embodiment of the apparatus, a biasing strength of a biasing member of the first assembly is different from a biasing strength of a biasing member of the second assembly.

In one embodiment of the apparatus, a stiffness of a torsional or linear spring of the first assembly is different from a stiffness of a torsional or linear spring of the second assembly.

In one aspect, there is provided a watercraft comprising the assembly or the apparatus in accordance with one or more of above embodiments,

In one aspect, there is provided a method of securing a foot of a person onto a surface of a watercraft, the method comprising: providing a retention member for receiving and securing the foot of in a default position; coupling the retention member to a rotatable member, said rotatable member for allowing the retention member to be rotated upon itself and about an axis substantially perpendicular to the surface of the watercraft; and allowing the rotatable member to rotate the retention member from the default position to a rotated position when a torque applied to the rotatable member exceeds a threshold.

In one aspect, the watercraft is selected from the group consisting of: sailboat, skiff, dinghy, catamaran, trimaran, surfboard, kitesurfing board, windsurfing board and wakeboarding board.

5 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1A is drawing showing a perspective view of an assembly in accordance with an exemplary embodiment.

10 Fig. 1B is drawing showing a perspective view of the assembly of FIG. 1A when the assembly is in a rotated position in accordance with an exemplary embodiment.

FIG. 2A is a schematic drawing showing a front view of an assembly in accordance with an exemplary embodiment.

15 FIG. 2B is a schematic drawing showing a top plan view of an assembly in accordance with an exemplary embodiment.

20 FIG. 3 is a drawing showing an assembly on a surface of a watercraft in accordance with an exemplary embodiment.

FIG. 4A is a schematic drawing showing a top plan view of a foot when secured in an assembly in accordance with an exemplary embodiment.

25 FIG. 4B is a schematic drawing showing a top plan view of a position of a foot when a retention member of the assembly of FIG. 4A is in a first rotated position.

FIG. 4C is a schematic drawing showing a top plan view of a position of a foot when a retention member of the assembly of FIG. 4A is in a second rotated position.

30 FIG. 5A is a schematic drawing showing a bottom plan view of an assembly in a default position in accordance with an exemplary embodiment.

35 FIG. 5B is a schematic drawing showing a bottom plan view of the assembly of FIG. 5A in a maximal rotated position in accordance with an exemplary embodiment.

FIG. 6A is a drawing showing a perspective view of an apparatus comprising a pair of first and second assemblies in accordance with an exemplary embodiment.

40 FIG. 6B is a drawing showing a perspective view of the apparatus of FIG. 6A when the assemblies are in rotated positions in accordance with an exemplary embodiment.

FIG. 7 is a drawing showing a bottom perspective view of an apparatus in accordance with an exemplary embodiment.

FIG. 8A is a schematic drawing showing a top plan view of each foot when secured in an apparatus disposed on a watercraft in accordance with an exemplary embodiment

FIG. 8B is a schematic drawing illustrating a momentum of a rearfoot portion of each foot when there is a deceleration of the watercraft in accordance with an exemplary embodiment.

FIG. 8C is a schematic drawing showing a top plan view of a position of each foot when the assemblies of the apparatus are in their respective rotated positions.

FIG. 8D is a schematic drawing showing a top plan view of a position of each foot after ejection from the first assembly and the second assembly of the apparatus.

FIG. 9A is a schematic drawing showing a bottom plan view of an apparatus in a default position in accordance with an exemplary embodiment.

FIG. 9B is a schematic drawing showing a bottom plan view of the apparatus of FIG. 9A in a maximal rotated position in accordance with an exemplary embodiment.

FIG. 10 is a schematic flowchart for illustrating method of securing a foot of a person onto a surface of a watercraft in accordance with an exemplary embodiment.

DETAILED DESCRIPTION

Exemplary embodiments of the disclosure will be better understood and readily apparent to one of ordinary skill in the art from the following discussions and if applicable, in conjunction with the figures. It should be appreciated that other modifications related to structural and material changes may be made without deviating from the core of the disclosure. Exemplary embodiments are not necessarily mutually exclusive as some may be combined with one or more embodiments to form new exemplary embodiments.

FIG. 1A is a drawing showing a perspective view of an assembly 100 for securing a foot of a person in accordance with an exemplary embodiment disclosed herein. In the exemplary embodiment, the assembly 100 comprises a retention member 102 and a rotatable member 104 coupled to the retention member 102. In an exemplary embodiment, the assembly 100 is disposed on a surface 106 of a watercraft and in such

an embodiment, the retention member 102 may be on top of the rotatable member 104 such that the rotatable member 104 is between the retention member 102 and the surface 106.

5 The retention member 102 may receive and thereby secure the foot of a person onto the surface 106 of the watercraft. The rotatable member 104 is rotatable upon itself and about an axis represented by the dotted line X as shown in FIG. 1A. The axis X is substantially perpendicular to the surface 106. In the exemplary embodiment, the axis is fixed and passes through the geometric centre 110 of the rotatable member 104. As the
10 retention member 102 is rigidly coupled to the rotation member 104, the rotation of the rotation member 104 also rotates the retention member 102 (and therefore a foot received therein) about the axis represented by the dotted line X substantially perpendicular to the surface 106. The axis may also pass through the geometric centre 108 of the retention member 102, and as such, the retention member 102 is also rotatable upon itself about
15 the axis X.

 In the exemplary embodiment, the rotatable member 102 is therefore also rotatable upon itself and about the axis X substantially perpendicular to the surface 106. It will be appreciated that in alternative embodiments of the assembly 100, the rotatable
20 member 102 may also be configured to have an axis of rotation that does not pass through the geometric centre 108 of the retention member 102 or the geometric centre 110 of the rotatable member 104. In such alternative embodiments, the rotatable member 102 is rotatable upon itself with the axis of rotation remaining substantially perpendicular to the surface 106, and the axis of rotation passes through the retention member 102 and
25 rotatable member 104.

 In the exemplary embodiment, the assembly 100, the rotatable member 104 and the retention member 102 are in their default, unrotated positions. The assembly 100, the rotatable member 104 and the retention member 102 may not move translationally.

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 In the example embodiment, the rotatable member 104 further comprises a biasing member (not shown) for biasing the rotatable member 104 and the retention member 102 to their default, unrotated positions.

35 FIG. 1B is a drawing showing a perspective view of the assembly 100 when the assembly 100 is in a rotated position. In the exemplary embodiment, the rotatable member 104 and the retention member 102 have been rotated from the default, unrotated position about the axis represented by the dotted line X, said axis substantially perpendicular to

the surface 106 and passing through the geometric centres 110 and 108 of the rotatable member 104 and the retention member 102 respectively. Rotation of the rotatable member 104 and the retention member 102 from the default position may be effected by a rotational force or a torque applied to the rotatable member 104 and/or the retention member 102, said rotational force or torque exceeding a threshold.

In an exemplary embodiment, the rotatable member 104 comprises a rotary pivot or a rotary bearing to allow for the rotation to occur about the axis X. In one example embodiment, as illustrated in FIGS. 1A and 1B, at least a portion of the rotatable member 104 is embedded or recessed within the surface 106 and the portion that is exposed i.e. the top surface of the rotatable member 104 is substantially flush with the surface 106. The exposed portion or the top surface of the rotatable member 104 may be substantially flat and disc-shaped. As may be appreciated, a disc shape has an infinite order of rotational symmetry about its geometric centre, and as such, the disc-shaped portion of the rotatable member 104 may remain substantially flush with the surface 106 at all angles of rotation about the geometric centre. As may be further appreciated, the seamless integration of the rotatable member 104 with the surface 106 advantageously allows the foot to experience minimal unevenness, protrusion or recess, when placed upon the rotatable member 104 and secured by the securing member 102. Therefore, comfort and performance are maximised.

It will be appreciated that the assembly 100 may also be mounted or installed on the surface 106 in alternative embodiments, such that the rotatable member 104 extends above the surface 106. In such alternative embodiments, the assembly 100 may comprise a housing for receiving at least a portion of the rotatable member 104 such that only a top surface of the rotatable member 104 remains exposed and substantially flush with a top surface of the housing. Such an assembly may be mounted or installed on the surface of 106 by coupling the housing to the surface 106, for example, by threaded means, screw means, nail means or the like. In an embodiment, the surface 106 is reinforced with backing to provide a sturdier surface for coupling to the housing of the assembly.

While such alternative embodiments may not provide as much comfort when compared with the embedded or recessed embodiment described above, they can be easier to install, replace and/or reposition relative to the surface 106. Such alternative embodiments also do not require a watercraft manufacturer to fabricate a recessed area in their watercrafts, which may involve substantial changes to the design and manufacturing process e.g. the manufacturer may have to make new moulds for a

watercraft with a recessed area. Further, such alternative embodiments may also give a user more flexibility in customising the exact installation or mounting position of the assembly. As may be further appreciated, certain types of watercrafts may be more suited to such alternative embodiments as compared to the embedded or recessed embodiment,

5 For example, as compared to a recessed embodiment, a mounted embodiment which may be positioned close to the midline of a windsurfing board can better preserve the structural integrity of the displacement board. As a further example, the mounted embodiment may also be implemented on kite boards and wakeboards which are typically of composite fibreglass/kelvar/carbon fiber material and are therefore too thin/fragile to

10 allow for a recessed embodiment. As an even further example, the mounted embodiment may also be implemented on certain classes of sailboats comprising only aluminium tubes and lacking sailing wings for receiving a recessed embodiment.

In the exemplary embodiment, the retention member 102 is in the form of a midfoot strap. With reference to FIG. 2A, the retention member 102 in the form of a midfoot strap

15 has its distal ends fixedly or removably attached to opposite edges of the exposed portion or the top surface of the rotatable member 104, such that the retention member 102 forms a curve shape or loop atop the rotatable member 104, thereby defining an aperture 202 for receiving and securing at least a midfoot portion of a foot therein.

20 It will be appreciated that the retention member is not limited to a midfoot strap, but may be provided in alternative manners such that it is capable of receiving and/or securing at least a forefoot portion of a foot and/or a midfoot portion of a foot to the top surface of the rotatable member 104. As the rotatable member 104 is coupled to the

25 watercraft, securing the foot to the rotatable member secures the foot to the watercraft.

In the exemplary embodiment, when a foot is inserted through the aperture 202, at least a portion of the retention member 102, for example, an inner face 206 of the retention member 102 is in contact with at least a portion of the top of the forefoot portion

30 and/or the midfoot portion of a foot received therein. In the exemplary embodiment, when a foot is inserted through the aperture 202, a portion of the sole of the foot, for example, the balls of the foot or the heel of the foot may face or fully contact or partially contact the top surface 208 of the rotatable member 104.

35 It may be appreciated that, the retention member 102 may be removably attached to the rotatable member 104, for washing or replacement purposes. The retention member 102 may be removably attached or fastened to the rotatable member 104, for

example, by way of hook and loop fasteners, Velcro tape, buckle, clasp, popper fastener or the like.

The retention member 102 may also be adjustable such that the size of the aperture 202 or loop can be adjusted to cater to different foot sizes, to provide comfort to the user.

In an exemplary embodiment, the retention member 102 does not receive and/or secure a rearfoot portion of a foot. The retention member 102 is preferably made of a material that is water-resistant. The retention member 102 is preferably made of a material which is comfortable to a person and which also provide sufficient grip so that a foot received therein would not slip out. Examples of such material include but are not limited to carbon fibre, fibreglass, high strength textiles or the like.

In an exemplary embodiment, the aperture 202 for receiving a foot has a width W of about 10 cm to about 16 cm and a height H of about 7 cm to about 13 cm.

FIG. 2B is a schematic drawing showing a top plan view of an assembly in accordance with an exemplary embodiment. As described above, in the exemplary embodiment, the rotatable member 104 comprises a biasing member 204 for biasing the rotatable member 104 and the retention member 102 to their default, unrotated positions. The biasing member 204 may be disposed at the underside of the rotatable member 104. That is the biasing member 204 is disposed underneath the rotatable member 104, on a bottom surface 210 (see FIG. 2A) opposite the surface 208 where the retention member 102 is disposed.

In the exemplary embodiment, the biasing member is in the form of a flat spiral torsional spring wound into the shape of Archimedes spiral with constant spacing between the coils. The end 212 at the outer coil of the spring may be fixed to a portion of the watercraft e.g. a fuselage or main body of the watercraft (or to a bracket fixedly and rigidly attached to a portion of the watercraft) while the end at the centre of the spring (hidden under rotatable member 104 in FIG. 2B) may be fixed to a portion of the rotatable member 104 to resist rotation of the rotatable member 104 relative to the watercraft. In the exemplary embodiment, the spring is a right hand wound spring. As may be appreciated, the spring can be right hand wound or left hand wound to resist clockwise or anti-clockwise rotations.

It will be appreciated that other spring types that may provide a restoring force to return the rotatable member 104 coupled thereto to its default, unrotated position may

also be used. For example, linear springs, extension springs, compression springs and other forms of torsional spring may be used to resist rotation of the rotatable member 104, when deployed in particular configurations. For example, in embodiments where the biasing member comprises a linear spring, one end of the linear spring may be fixed to a portion of the watercraft (or to a bracket fixedly and rigidly attached to a portion of the watercraft) while the other end may be fixed to a portion of the rotatable member 104 e.g. a proximal perimeter of the rotatable member 104, to resist movement of the proximal perimeter of the rotatable member 104 where the other end is fixed. In this way, rotation of the rotatable member 104 is resisted.

FIG. 3 is a drawing showing an assembly 300 on a surface 308 of a sailing wing located or disposed at the port side of a watercraft, in an example embodiment. The assembly 300 functions substantially similarly to the assembly 100 of FIG. 1 and 2. In the exemplary embodiment, the retention member 302 and the rotatable member 304 are in their default, unrotated positions when the watercraft is moving in the direction of 306. In its default, unrotated position, the retention member 302 may receive and secure a foot such that the length of the received foot is substantially perpendicular to the direction of motion 306. As may be appreciated, when a sailor is trapezing on a sailboat, he may stand on a sailing wing at the starboard side or the port side of a watercraft with the front of his body and his toes pointing towards the centreline (not shown) of the watercraft.

The assembly 300 may therefore be disposed on a sailing wing as shown in FIG. 3 such that the retention member 302 is oriented to receive a foot with the toes pointing towards the centreline of the watercraft and with the length of the foot substantially perpendicular to the direction of motion 306 (or the centreline) of the watercraft. As may be further appreciated, from the position described above, the sailor may also lower his body using portions of the sole his feet to leverage upon an outer edge of the sailing wing until his body is substantially parallel to the surface of the water when trapezing. In an exemplary embodiment therefore, the assembly 300 is disposed at a proximal outer edge of a sailing wing of a watercraft (as shown in FIG. 3). In an exemplary embodiment, the retention member 302 is elastic or defines an aperture that is sufficiently big to provide sufficient room or give, to allow a foot received therein to be angled upward from a rearfoot portion away from the surface which the assembly 300 is disposed on.

FIG. 4A is a schematic drawing showing a top plan view of a foot 406 when secured in an assembly 400 comprising a retention member 402 in the default position 418 when a watercraft is moving in a direction 412, in an exemplary embodiment. The

assembly 400, comprising a retention member 402, functions substantially similarly to the assembly 100 and the assembly 300 of FIGS. 1-3. In the exemplary embodiment, the assembly comprises a centre or pivot 404 that aligns with the centre or pivot of the retention member 402 and the centre or pivot of a rotatable member hidden under the foot 406 and thus not shown in this top plan view FIG. 4A. When the retention member 402 is in the default position as shown in FIG. 4A, the retention member 402 may receive and secure the foot 406 such that the length of the received foot 406 is substantially perpendicular to the direction of motion 412 or the centreline of the watercraft (not shown). In the exemplary embodiment, the retention member 402 comprises a front edge 416 nearer to the bow of a watercraft and a back edge 414 nearer to the stern of a watercraft, the front edge 416 and the back edge 414 being fixedly or removably attached to the rotatable member. In the exemplary embodiment, an axis that joins at least a portion of the front edge 416 and at least a portion of the back edge 414 is substantially parallel to the direction of motion 412. The dotted line S passing through the centre or pivot 404 is used as a reference line to illustrate subsequent rotations.

When there is a sudden deceleration e.g., resulting from a head-on collision, of the watercraft moving in the direction 412, the midfoot and/or forefoot portion 408 (408 denotes that non-rearfoot portion) of the foot 406 may also decelerate from a high velocity due to a reactive force exerted by the retention member 402 disposed on the watercraft. In contrast, a rearfoot portion 410 of the foot 406 that is not in contact with or secured with the retention member 402 may continue to move in the direction 412 at the high velocity due to inertia. As may be appreciated, if the deceleration is large and if the retention member is rigid, a large twisting force may be exerted on the ankles, the metatarsal bones and potentially the knees, resulting in injuries to the sailor.

In an exemplary embodiment, when there is a deceleration of the watercraft moving in the direction 412, the momentum of the rearfoot may result in a clockwise rotational force or torque being applied to the retention member 402. As the retention member 402 is coupled to a rotatable member, this results in a rotational force or torque being applied to the rotatable member. If the torque exceeds a pre-determined threshold, for example when there is a sharp deceleration, the rotatable member may rotate upon itself about the pivot axis 404. In turn, the retention member 402 (and the foot 406 received within) similarly rotate about the pivot axis 404 in a clockwise manner. It will be appreciated that the rotatable member and the retention member 402 rotate in a clockwise manner during a sharp deceleration, when the assembly 400 is mounted or disposed on the port side of the watercraft. Conversely, when the assembly 400 is mounted or

disposed on the starboard side of the watercraft, the rotatable member and retention member 402 rotate in an anti-clockwise manner during a sharp deceleration.

In the exemplary embodiment of FIG. 4B, the retention member 402 and the foot 406 received therein are rotated by an angle θ' with respect to the reference line S to a first rotated position 420. In an exemplary embodiment, θ' is from between more than 0° and 90° ($0^\circ < \theta' \leq 90^\circ$). As may be appreciated, rotation of the retention member 402 enables the forefoot portion and/or the midfoot portion 408 received therein to move in a substantially concerted manner with the unsecured rearfoot portion 410, thereby mitigating and/or sparing the ankles, the metatarsal bones and the knees from potentially experiencing any large twisting forces or strain and reducing the chances of injuries.

Further, at the first rotated position 420 as shown in FIG. 4B, the force applied on the edges 414, 416 of the retention member 402 caused by momentum of the person's body is no longer substantially parallel to the axis that joins the front edge 416 and the back edge 414 (i.e., along the length of the strap), and may instead be substantially perpendicular to the axis. Given the momentum of the sailor in the direction of motion 412, this allows the foot 406 to be dislodged/disengaged/ejected from the retention member 402, safely releasing the sailor from the retention member 402 and watercraft.

In an exemplary embodiment, the retention member reverts to its default position 418 after dislodgement/disengagement/ejection of the foot 406. The rotatable member may rotate the retention member 402 in an anti-clockwise manner such that it reverts to its default position (as shown in FIG. 4A) by virtue of a restoring force applied by the biasing member such as e.g., a torsional spring comprised therein. In such an exemplary embodiment, the assembly 400 does not require manual reset to the default position.

FIG. 4C is a schematic drawing showing a top plan view of a position of the foot 406 when the retention member 402 is in a second rotated position 422. As may be appreciated, when the deceleration of the watercraft moving in a direction 412 is larger than that in FIG. 4B, a larger rotational force or torque may be applied to the rotatable member which may cause the retention member 402 to be rotated clockwise by a greater angle θ'' with reference to reference line S to a second rotated position 422. In an exemplary embodiment, θ'' is from between 30° and 90° ($30^\circ \leq \theta'' \leq 90^\circ$).

At the second rotated position 422, the force caused by momentum of the person's body may also allow the foot 406 to be dislodged or ejected from the retention member 402. In an exemplary embodiment, the retention member 402 in the second rotated

position 422 may eject the foot 406 in a different direction, angle or time as compared to when the retention member 402 is in the first rotated position 420 as shown in FIG. 4B.

In an exemplary embodiment, the second rotated position is the maximal rotated position of the retention member 402 beyond which the retention member 402 may not be further rotated clockwise. In an exemplary embodiment therefore, the assembly 400 may comprise one or more stop members for limiting the rotation of the retention member 402 and the rotatable member.

FIG. 5A is a schematic drawing showing a bottom plan view of an assembly in a default position in accordance with an exemplary embodiment. The assembly 500 functions substantially similarly to the assemblies 100, 300 and 400 of FIGS. 1-4. In the exemplary embodiment, the assembly 500 comprises stop members 508 and 510. In the exemplary embodiment, stop member in the form of protrusion 508 projects from a bottom surface of the rotatable member 504 i.e. opposite the surface where the retention member 502 is disposed. The stop member in the form of stopper 510 may project from a portion of the watercraft or where the assembly 500 comprises a housing, from a base on the housing. In the exemplary embodiment, the stop member 510 is positioned such that it lies in the path of stop member 508 when the stop member 508 is rotated clockwise in tandem with rotatable member 504. The stop member 508 is therefore configured to meet with the stop member 510 to prevent a further rotation of the rotatable member 504. In other words, the protrusion 508 moves along a rotational path in tandem with rotation of the rotatable member. Positioning the stopper 510 at a point on the rotational path prevents further rotation of the rotatable member 504.

FIG. 5B is a schematic drawing showing a bottom plan view of the assembly of FIG. 5A in a maximal rotated position in accordance with an exemplary embodiment. In the exemplary embodiment, the rotatable member 504 is rotated clockwise from its default position and the stop member 508 projecting therefrom comes into contact with the stop member 510. As both stop members 508 and 510 are rigid, further clockwise rotation of the rotatable member 504 is prevented, and the rotatable member 504 is therefore at its maximal rotated position. As may be appreciated, stop members 508 and 510 act as mechanical limiters to prevent the assembly 500 from rotating past a set or pre-determined point.

In example embodiments, the assembly is configured to rotate to the maximum angle and be mechanically limited during instances of high deceleration such as e.g., high speed collisions. In less serious accidents where the deceleration is less, the deceleration

force may not be enough to fully extend the biasing member in the form of a torsional spring 504 such that the stop member 508 projecting from the rotatable member 504 does not reach the stop member 510. It will be appreciated that the example embodiments are directed at addressing injuries resulting from the more dangerous former scenario of e.g., high speed collisions.

In an exemplary embodiment, the rotatable member 504, by virtue of the biasing strength of the biasing member in the form of a spring 506, is configured to rotate to the maximal rotated position when there is a sharp or high deceleration of the watercraft in the magnitude typical of that during a serious emergency/accident/collision/broach. In less serious accident/collision/broach, the deceleration force is less and this translates to a smaller extension of the spring. Consequently, the rotatable member 504 may not reach the maximal rotated position, and a received foot may not be dislodged or ejected from the retention member 502. As may be appreciated, in less serious accident/collision/broach, where the deceleration force is less, the potential for serious injury is also reduced.

It may be appreciated that during the normal motion of a watercraft, a certain level of rotational force or torque may also be exerted on the retention member and/or the rotatable member. In an exemplary embodiment, the retention member and/or the rotatable member is configured to remain substantially stationary in the default position during such normal motion. Therefore, the threshold rotational force or torque is configured to be more than the rotational force or torque exerted on the retention member and/or the rotatable member during a normal motion condition of the watercraft. It may be appreciated that the assembly disclosed herein may function like a rigid foot-retaining assembly such as a rigid foot strap during normal motion condition, with the rotation of the assembly only activated when during an emergency, a crash or a broach. For example, a sharp deceleration exceeding $20 \text{ m/s}^2 - 50 \text{ m/s}^2$ may be considered an emergency, a crash or a broach and the threshold rotational force or torque may be configured accordingly. The threshold torque may be determined or fine-tuned by determining the typical torque applied to the assembly during normal sailing of the watercraft in various wind and wave condition, and also the torque applied to the assembly during a sudden deceleration.

It may be further appreciated that the threshold torque may be determined or fine-tuned by determining the typical torque applied to the assembly during normal sailing of

the watercraft in various wind and wave condition, and also the torque applied to the assembly during a sudden deceleration.

In example embodiments where the rotatable member comprises a biasing member in the form of a spring, the threshold rotational force or torque required to rotate the rotatable member may be varied by varying a stiffness of the spring. An example below shows how a suitable spring stiffness may be computed for a torsional spring.

Example

In this example, the following variables are used:

L: Distance from rotation centre to body on foot;

$F_{\max}$: Maximum force exerted by body due to momentum;

$T_{\max}$: Maximum torque exerted by body onto torsional spring;

$\theta_{\max}$: maximum range of travel of torsional spring;

$V_{\max}$: Maximum velocity of boat;

t_c : Collision time;

m: typical mass of a sailor; and

k: torsional spring stiffness.

Taking L to be 0.12m, $V_{\max}$ to be 10 m/s, m to be 80 kg and the collision time to be 0.5s, and setting $\theta_{\max}$ to be $\pi/2$,

Using Newton's 2nd Law:

$$F_{\max} = m \frac{dv}{dt} = m \frac{v_{\max}}{t_c}$$

$$F_{\max} = 80 \frac{10}{0.5} = 1600 \text{ N}$$

Using the definition of the torsional spring stiffness:

$$T_{\max} = k \theta_{\max}$$

$$F_{\max} L = k \theta_{\max}$$

$$k = \frac{F_{\max} L}{\theta_{\max}} = \frac{1600(0.12)}{\pi / 2} = 122 \text{ Nm/rad}$$

For a collision time of 0.5s, the suitable torsional spring stiffness is computed to be 122 Nm/rad.

If the collision time is reduced to 0.2s in the computation, then

Using Newton's 2nd Law:

$$F_{\max} = m \frac{dv}{dt} = m \frac{v_{\max}}{t_c}$$

$$F_{\max} = 80 \frac{10}{0.2} = 4000 \text{ N}$$

Using the definition of the torsional spring stiffness:

$$T_{\max} = k \theta_{\max}$$

$$F_{\max} L = k \theta_{\max}$$

$$k = \frac{F_{\max} L}{\theta_{\max}} = \frac{4000(0.12)}{\pi / 2} = 306 \text{ Nm/rad}$$

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Thus, for a collision time of 0.2s, the suitable torsional spring stiffness is computed to be 306 Nm/rad.

10 In an exemplary embodiment, the torsional spring stiffness is from 100 Nm/rad to 1000 Nm/rad inclusive.

In an exemplary embodiment, the biasing member in the form of a spring is adjustable or replaceable to vary, tune, regulate or control variables including the threshold rotational force/torque, the rotated position, a biasing strength of the biasing member, or an ejection direction, angle or time of the user. For example, the length of the spring when the rotatable member is in its default unrotated position may be adjusted to vary a preload of the spring, and thereby vary a force or strength of the spring. Such methods of adjusting the preload of a spring are known to the person skilled in the art. For example, for an extension spring, one or both ends of the spring may be displaced to be affixed to a different point on the watercraft (directly or indirectly through a bracket) and/or to a different point on the rotatable member to vary an initial extension of the spring and therefore a preload of the spring. In an exemplary embodiment therefore, a plurality of brackets for coupling to an end of a spring may be predisposed at distinct points on the rotatable member and/or portions of the watercraft to facilitate adjustment to the length of the spring. As a further example, for a compression spring, the compression spring may be wound around a structure with one or both ends of the spring bound by threaded bolts or nuts or lock nuts, and the length of the spring may be reduced from its free length to introduce a particular preload by adjusting the threaded bolts or nuts or lock nuts by hand or a C-spanner. Commercially available preload adjusters such as a hydraulic spring preload adjuster or a pneumatic spring preload adjuster may also be used to vary a preload of the spring.

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As may be appreciated, the force of a spring depends on the preload, which in turn depends on the initial extension or compression of the spring. Therefore, by extending or compressing the spring e.g. moving the spring translationally, the preload can be adjusted to be higher or lower, thereby making the spring stronger or weaker. For example, for an extension spring, if the extension of the spring is reduced, the preload (at the default position) becomes reduced and the spring requires a smaller force to move. Conversely, if the extension of the same spring is increased, the preload becomes increased and the spring requires a larger force to move. As may be appreciated, by adjusting a length of the spring, the threshold rotational force/torque may therefore be adjusted accordingly without replacing the spring. This method may allow for the threshold rotational force/torque to be finely-tuned, as the length of the spring may be adjusted finely.

As may be appreciated, for coarser changes to the variables, the spring may be replaced completely with another spring of a different stiffness/ spring constant.

Although FIGS. 4A-4C and 5A-5B illustrate a clockwise rotation of an assembly from the default, unrotated position, it will be appreciated that embodiments of the assembly may also rotate in an anti-clockwise manner from the default, unrotated position when embodiments of the assembly are disposed on an opposite side of a watercraft from that illustrated in FIGS. 4A-4C and 5A-5B.

FIG. 6A is a drawing showing a perspective view of an apparatus or combined assembly 600 comprising a pair of assemblies – a first assembly 602 and a second assembly 604 in accordance with an exemplary embodiment disclosed herein. Each of the first assembly 602 and the second assembly 604 functions substantially similarly to the assemblies 100, 300, 400 and 500 of FIGS. 1-5.

In the exemplary embodiment, when the apparatus or combined assembly 600 is disposed on a watercraft, the first assembly 602 and the second assembly 604 are disposed substantially adjacent to each other along a direction substantially parallel to the centreline of watercraft. The rotatable member 608 of the first assembly 602 and the rotatable member 612 of the second assembly 604 may be rotatable upon themselves and about respective axis X' and X'', each axis substantially parallel with each other, and respectively substantially perpendicular to a surface of the apparatus or combined assembly 600. The retention member 606 coupled to the rotatable member 608, and

the retention member 610 coupled to the rotatable member 612 may therefore also rotate about the axis X' and X'' respectively. In the exemplary embodiment shown in FIG. 6A, the rotatable members 608 and 612 and the retention members 606 and 610 are in their default, unrotated positions. In the exemplary embodiment, the default, unrotated position of the assembly 602 with respect to the axis X' is the same as the default, unrotated position of the assembly 604 with respect to the axis X''.

FIG. 6B is a drawing showing a perspective view of the apparatus of FIG. 6A when the assembly 602 and the assembly 604 are in their rotated positions in accordance with an exemplary embodiment disclosed herein. In the exemplary embodiment, the rotated position of the assembly 602 with respect to the axis X' is different from the rotated position of the assembly 604 with respect to the axis X''. At any given time and/or condition therefore, the assembly 602 may rotate by an angle different than that of the assembly 604.

FIG. 7 is a drawing showing a bottom perspective view of an apparatus 700 disposed on a sailing wing 712 in accordance with an exemplary embodiment disclosed herein. The apparatus 700 functions substantially similarly to the apparatus 600 in FIG. 6. In the exemplary embodiment, each of the first assembly 702 and second assembly 704 further comprises a respective biasing member 708 and a biasing member 710, disposed at the bottom of the assemblies.

The biasing member 708 and the biasing member 710 may be sealed or covered from an underside of the sailing wing or otherwise exposed on an underside of the sailing wing. The seal or cover may be removed to allow for easy access to the biasing member when adjustment of e.g., the threshold torque or strength of the spring is required. In an exemplary embodiment, the biasing member is made of stainless steel, optionally marine-grade stainless steel.

FIG. 8A is a schematic drawing showing a top plan view of each foot 806 and 808 when secured in a first assembly 802 and a second assembly 804 respectively in an apparatus 800 in accordance with an exemplary embodiment disclosed herein. The apparatus 800 functions substantially similarly to the apparatuses 600 and 700 in FIGS. 6 and 7. In the exemplary embodiment, when the motion of a watercraft on which the apparatus 800 is disposed thereon is in the direction 810, the first assembly 802 and the second assembly 804 secure each foot 806 and 808 in their default positions 812 and

814 respectively such that the length of each foot is substantially perpendicular to the direction of motion 810. The dotted line S1 and S2 are used as reference lines to illustrate subsequent rotations.

5 FIG. 8B is a schematic drawing illustrating a momentum of a rearfoot portion of each foot 806 and 808 when there is a deceleration of the watercraft moving in the direction of 810. When there is a deceleration of the watercraft, the momentum of the unsecured rearfoot portion of each foot 806 and 808 may be in the direction of 816 and 818 respectively, both of which are parallel to the direction of motion of the watercraft 810. 10 The momentum may cause a clockwise torque to be applied to the assembly 802 and the assembly 804. In an exemplary embodiment, when the torque exceeds a pre-determined threshold, the assembly 802 and the assembly 804 rotate in a clockwise direction,

15 FIG. 8C is a schematic drawing showing a top plan view of a position of each foot 806 and 808 when the first assembly 802 and the second assembly 804 are in their respective rotated positions 820 and 822. In the exemplary embodiment, the first assembly 802 (and therefore the foot 806 received therein) is rotated by an angle θ_1 from the reference line S1 to a position 820 while the second assembly 804 (and therefore the foot 808 received therein) is rotated by a different angle θ_2 from the reference line S2 to 20 a position 822.

25 In an exemplary embodiment, the rotated position 820 is a maximal rotated position of the first assembly 802. In an exemplary embodiment, the rotated position 822 is a maximal rotated position of the second assembly 804. In an exemplary embodiment therefore, the rotated position or the maximal rotated position of the first assembly 802 is different from the rotated position or the maximal rotated position of the first assembly 804 at any given time or condition. The momentum of the foot 806 is in the direction of 824 and the momentum of the foot 808 is in the direction 826, both directions of which are substantially parallel to the direction of motion 810.

30 FIG. 8D is a schematic drawing showing a top plan view of a position of each foot 806 and 808 after ejection from the first assembly 802 and the second assembly 804. At the rotated positions 820 and 822, the force applied by the sailors on the retention members 802 and 804 (caused by momentum of the sailors' body) is no longer 35 substantially parallel along the length of the strap. Given the momentum of the sailors in the direction of motion 810, this allows their feet 806 and 808 to be

dislodged/disengaged/ejected from their respective retention members 802 and 804, safely releasing the sailors from their retention members and watercraft.

As shown in FIG. 8D, the momentum of the sailor's body causes the foot 806 and the foot 808 to be ejected or dislodged from the assembly 802 and the assembly 804 respectively in the direction of 828 and 830 respectively. As may be appreciated, during sudden deceleration resulting from e.g., a collision or crash, a user whose foot 806 is retained in the first assembly 802 may be ejected or flung from the first assembly 802 in a different direction from another user whose foot 808 is retained in the second assembly 804 due to the different maximal positions of the respective assemblies 802, 804, such that the two users do not collide in their ejection paths.

In an exemplary embodiment, when the apparatus 800 is disposed on a port side of the watercraft moving in the direction 810, the first assembly 802 is located nearer to a bow of a watercraft and the second assembly 804 is located nearer to the stern of a watercraft, and the angle θ_1 is greater than the angle θ_2 at any given time or condition during a sharp deceleration. In an exemplary embodiment, when the apparatus 800 is disposed on a starboard side of the watercraft moving in the direction 810, the first assembly 802 is located nearer to a stern of a watercraft and the second assembly 804 is located nearer to the bow of a watercraft, and the angle of anti-clockwise rotation of the first assembly 802 from the default position is smaller than the angle of that of the second assembly 804 at any given time or condition during a sharp deceleration.

It may be therefore appreciated that the biasing strength of a biasing member of the first assembly 802 may be different from that of the second assembly 804 in order to provide for different release angles when similar torques are provided. For example, the stiffness or the preload of a spring of the first assembly 802 may be different from that of the second assembly 804. It may also be appreciated that the threshold torque required to rotate the assembly 802 may also be different from that of the second assembly 804.

FIG. 9A is a schematic drawing showing a bottom plan view of an apparatus in a default position in accordance with an exemplary embodiment. The apparatus 900 functions substantially similarly to the apparatuses 600, 700 and 800 of FIGS. 6-8. In the exemplary embodiment, the apparatus 900 comprises a first assembly 902 comprising a pair of stop members 906 and 910, and a second assembly 904 comprising a pair of stop members 908 and 912. In the exemplary embodiment, stop members 906 and 908 project a bottom surface of the rotatable members 914 and 916 respectively i.e. opposite the surface where the retention members 918 and 920 are disposed. The stop members 910

and 912 may project from a portion of the watercraft or a base of the apparatus 900. In the exemplary embodiment, the stop member 910 is positioned such that it lies earlier in the path of stop member 906 when the stop member 906 is rotated clockwise in tandem with rotatable member 914, whereas the stop member 912 is positioned such that it lies later in the path of stop member 908 when the stop member 908 is rotated clockwise in tandem with rotatable member 916. That is, the rotatable member 916 has to rotate by a greater angle from the default position before the stop member 908 projecting therefrom contacts the stop member 912, as compared to a small angle of rotation required by the rotatable member 914 before the stop member 906 projecting therefrom contacts the stop member 910.

FIG. 9B is a schematic drawing showing a bottom plan view of the apparatus of FIG. 9A in a maximal rotated position in accordance with an exemplary embodiment. In the exemplary embodiment, the first assembly 902 and the second assembly 904 are rotated clockwise from their default positions and the stop members 906 and 908 come into contact with the stop members 910 and 912 respectively. As the stop members are rigid, further clockwise rotation of the assemblies 902 and 904 are prevented, and the assemblies 902 and 904 are therefore in their respective maximal rotated positions. As mentioned above, as compared to the stop member 912, the stop member 910 is positioned earlier along the path of clockwise rotation of the rotatable member from the default position. The maximum rotated angle of the first assembly 902 is therefore smaller than that of the second assembly 904. As may be appreciated, this allows a user of the first assembly 902 to eject from a different angle from another user of the second assembly 904 when the assemblies are in their respective maximal rotated positions, thereby minimising the chances of the two users colliding with each other in their ejection paths.

It will be appreciated that the apparatus comprising a first assembly and a second assembly may each secure a left foot of two sailors or a right foot of two sailors when the sailors are trapezing.

The terms "coupled" or "connected" as used in this description are intended to cover both directly connected or connected through one or more intermediate means, unless otherwise stated.

The term "adjacent" used herein when referring to two elements refers to one element being in close proximity to another element and may be but is not limited to the

elements contacting each other or may further include the elements being separated by one or more further elements disposed therebetween.

The term "and/or", e.g., "X and/or Y" is understood to mean either "X and Y" or "X or Y" and should be taken to provide explicit support for both meanings or for either meaning.

Further, in the description herein, the word "substantially" whenever used is understood to include, but not restricted to, "entirely" or "completely" and the like. In addition, terms such as "comprising", "comprise", and the like whenever used, are intended to be non-restricting descriptive language in that they broadly include elements/components recited after such terms, in addition to other components not explicitly recited. Further, terms such as "about", "approximately" and the like whenever used, typically means a reasonable variation, for example a variation of +/- 5% of the disclosed value, or a variance of 4% of the disclosed value, or a variance of 3% of the disclosed value, a variance of 2% of the disclosed value or a variance of 1% of the disclosed value.

Furthermore, in the description herein, certain values may be disclosed in a range. The values showing the end points of a range are intended to illustrate a preferred range. Whenever a range has been described, it is intended that the range covers and teaches all possible sub-ranges as well as individual numerical values within that range. That is, the end points of a range should not be interpreted as inflexible limitations. For example, a description of a range of 1° to 5° is intended to have specifically disclosed sub-ranges 1° to 2°, 1° to 3°, 1° to 4°, 2° to 3° etc., as well as individually, values within that range such as 1°, 2°, 3°, 4° and 5°. The intention of the above specific disclosure is applicable to any depth/breadth of a range.

In various embodiments, the assembly and the apparatus are devoid of a power source. In various embodiments, the assembly and the apparatus are devoid of an electrical power source or any sources that directly or indirectly produce electrical energy.

In various embodiments, the assembly and the apparatus comprise a mechanized assembly or apparatus.

In some embodiments, the retention member of the assembly and the apparatus is made of a soft and/or a conformable material suitable for conforming to the shape of a foot received therein. In some embodiments, the retention member is not made of a hard material such that it is unsuitable for conforming to the shape of a foot received therein. It will be

appreciated that that the retention member may secure a foot more effectively when it conforms to the shape of the foot. In some embodiments, the retention member of the assembly and the apparatus is made of a substantially elastic material such that it is suitable for allowing a foot received therein to be angled upward away from the surface on which the assembly or the apparatus is disposed on. In some embodiments, the retention member remains substantially intact during its rotation. Examples of materials suitable for the retention member include but are not limited to carbon fibre, fibreglass, high strength textiles, rubber or the like.

In various embodiments, the rotatable member comprises a rotary pivot or a rotary bearing to allow for the rotation to occur. Examples of rotary pivot and rotary bearing include but are not limited to pivot bearing, roller bearing, ball bearing and the like. As may be appreciated, a ball bearing may comprise an outer ring, an inner ring and a plurality of balls disposed between the outer ring and the inner ring. In embodiments where the rotatable member comprises a ball bearing, the outer ring may be fixed to at least a portion of the watercraft whereas the inner ring may be directly coupled to the rotatable member opposite the surface where the retention member is coupled.

In various embodiments, there is also provided a watercraft comprising the assembly or the apparatus. In various embodiments, the watercraft comprises a foiling watercraft or a non-foiling watercraft. In various embodiments, the watercraft is selected from the group consisting of: sailboat, skiff, dinghy, catamaran, trimaran, surfboard, kitesurfing board, windsurfing board and wakeboarding board.

In various embodiments, reference to a foot herein comprises reference to a shoe or any footwear in which a foot may be disposed.

FIG. 10 is a flowchart 1000 illustrating a method of securing a foot of a person onto a surface of a watercraft, in an exemplary embodiment. At step 1002, a retention member for receiving and securing the foot of in a default position is provided. At step 1004, the retention member is coupled to a rotatable member. The rotatable member allows the retention member to be rotated upon itself and about an axis substantially perpendicular to the surface of the watercraft. At step 1004, the rotatable member is allowed to rotate the retention member from the default position to a rotated position when a torque applied to the rotatable member exceeds a threshold.

In exemplary embodiments, the method may further comprise the step of biasing the retention member to the default position with a biasing member.

In exemplary embodiments, the step of providing a retention member for receiving and securing the foot may comprise securing the received foot such that length of the received foot is substantially perpendicular to a direction of motion of the watercraft in the default position.

In exemplary embodiments, the rotatable member may allow the retention member to be rotated from between more than 0° and 90° from the default position.

In exemplary embodiments, the method may further comprise providing a stop member to prevent a further rotation of the rotatable member, when the rotatable member has rotated to a maximal rotated position.

In exemplary embodiments, the stop member comprises a protrusion projecting from a surface of the rotatable member, such that the protrusion moves along a rotational path in tandem with rotation of the rotatable member, and positioning a stopper at a point on the rotational path prevents further rotation of the rotatable member.

In exemplary embodiments, the method may further comprise configuring the rotatable member to comprise a maximal rotated position, wherein the maximal rotated position comprises a position where retention member is rotated from between 30° and 90° from the default position.

In exemplary embodiments, the step of providing a retention member may comprise providing a midfoot strap.

In exemplary embodiments, the rotatable member may comprise a rotary pivot or a rotary bearing.

In exemplary embodiments, the method may further comprise adjusting the biasing member to vary the threshold, the rotated position, the maximal rotated position or a biasing strength of the biasing member.

In exemplary embodiments, the biasing member comprises a torsional spring or a linear spring.

In exemplary embodiments, wherein the biasing member may comprise a torsional spring, the stiffness of the torsional spring may be from 100 Nm/rad to 1000 Nm/rad.

In exemplary embodiments, the threshold is more than the torque applied to the rotatable member during normal motion condition of the watercraft without sharp deceleration.

5 In exemplary embodiments, the exposed area of the rotatable member may be flush with the surface of the watercraft.

In exemplary embodiments, the retention member may be devoid of a power source.

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In exemplary embodiments, the rotatable member is configured to be rotatable in the anti-clockwise direction from the default position, when the rotatable member is disposed on the starboard side of the watercraft.

15 In exemplary embodiments, the rotatable member is configured to be rotatable in the clockwise direction from the default position, when the rotatable member is disposed on the port side of the watercraft.

20 In one example embodiment, a method of securing a pair of feet onto a surface of a watercraft is provided. The method may comprise providing a pair of first and second assemblies, wherein the first assembly is configured to provide a first rotated position that is at a different angle from the rotated position of the second assembly.

25 In the example embodiment, a biasing strength of a biasing member of the first assembly is different from a biasing strength of a biasing member of the second assembly.

In another example embodiment, a stiffness of a spring of the first assembly is different from a stiffness of a spring of the second assembly.

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Currently commercially available foot straps are static, rigid and fit relatively tightly around the feet. Thus, they prevent the foot from becoming free during the occurrence of a sharp deceleration. The user may therefore experience large twisting forces on the ankle, the metatarsal bones of foot and potentially the knee, all of which are particularly
35 fragile, leading to injuries.

Unlike current commercially available foot straps, embodiments of the assembly and apparatus disclosed herein are torque-sensitive and may release the foot when the foot

applies a certain level of torque to the assembly. The torque required for release may only present during sudden deceleration and hence embodiments of the assembly and apparatus may only activate release in times of emergencies. At all other times, embodiments of the assembly and apparatus may operate and function just like a static foot strap. Thus, 5 embodiments of the present application seek to advantageously provide, through improved equipment design, reduced incidences of sailing injuries, while faster boats gain popularity worldwide.

Advantageously, embodiments of the assembly and apparatus operate by way of a 10 passive mechanism/mechanical system (i.e. no active power required for operation). Embodiments of the assembly and apparatus may harness deceleration forces for safe, controlled, regulated and coordinated release of two sailors, for example a skipper and a crew, to spare the foot, ankle and knee from excessive rotational, valgus and traction forces. Embodiments of the assembly and apparatus do not require the sailors to manually release 15 the assembly and apparatus to free themselves. Embodiments of the assembly and apparatus allow for quick release of the sailors during a sharp deceleration.

The exemplary embodiment of the combined assembly as illustrated in e.g., FIG. 6-9, may further advantageously avoid potential serious collisions between the two sailors when 20 they are ejected from a watercraft, as they are ejected in different angles.

Further, embodiments of the assembly and apparatus may be further customized or individualized according to the user to maximize their operation performance. For example, to determine the ideal threshold torque for rotating the assembly and apparatus for a user, on- 25 water measurements of the typical torque exerted by the user during normal sailing in various wind and wave conditions, as well as the torque exerted during a sudden deceleration may be evaluated.

It is envisaged that, embodiments of the assembly and apparatus described herein 30 may be introduced to competitive high performance boats, specifically the 49er and 49er FX, to reduce the high injury rates amongst competitive sailors. Embodiments of the assembly and apparatus described herein may also be introduced to more types of boats (e.g. the Olympic catamaran class, the Nacra 17) and boards as well (e.g. kitesurfing boards, windsurfing boards, wakeboarding boards). Boat- and board-builders from around the world may therefore 35 also stand to benefit.

It will be appreciated by a person skilled in the art that other variations and/or modifications may be made to the specific embodiments without departing from the spirit or

scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

CLAIMS

1. An assembly for securing a foot of a person onto a surface of a watercraft, said assembly comprising:
 - 5 a retention member for receiving and securing the foot in a default position;
 - a rotatable member coupled to the retention member for allowing the retention member to be rotated upon itself and about an axis substantially perpendicular to the surface of the watercraft, wherein the rotatable member is configured to rotate the retention member from the default position to a rotated position when a torque applied to the rotatable member exceeds a threshold, said rotation of the retention member allowing the foot to be dislodged from the retention member along a plane substantially parallel to the surface of the watercraft; and
 - 10 a stop member configured to prevent a further rotation of the rotatable member, when the rotatable member has rotated the retention member to a maximal rotated position.
2. The assembly of claim 1, wherein said rotation of the retention member allowing the foot to be dislodged from the retention member is caused by momentum of the person's body and deceleration of the watercraft.
3. The assembly of claim 1 or claim 2, wherein the retention member is configured to secure the received foot such that length of the received foot is substantially perpendicular to a direction of motion of the watercraft in the default position.
4. The assembly of claim 3, wherein said rotation of the retention member allows the foot to be dislodged from the retention member in a direction that is substantially in the direction of motion of the watercraft.
5. The assembly of any one of claims 1-4, wherein the rotatable member comprises a biasing member for biasing the retention member to the default position.

6. The assembly of any one of claims 1-5, wherein the rotated position comprises a position where the retention member is rotated from between more than 0° and 90° from the default position.
- 5 7. The assembly of any one of claims 1-6, wherein the stop member comprises a protrusion projecting from a surface of the rotatable member, such that the protrusion moves along a rotational path in tandem with rotation of the rotatable member, and positioning a stopper at a point on the rotational path prevents further rotation of the rotatable member.
- 10 8. The assembly of any one of claims 1-7, wherein the maximal rotated position comprises a position where retention member is rotated from between 30° and 90° from the default position.
- 15 9. The assembly of any one of claims 1-8, wherein the retention member comprises a midfoot strap.
- 20 10. The assembly of any one of claims 1-9, wherein the rotatable member comprises a rotary pivot or a rotary bearing.
- 25 11. The assembly of any one of claims 5-10, wherein the biasing member is adjustable to vary the threshold, the rotated position, the maximal rotated position or a biasing strength of the biasing member.
- 30 12. The assembly of any one of claims 5-11, wherein the biasing member comprises a torsional spring or a linear spring.
- 35 13. The assembly of any one of claims 1-12, wherein the threshold is more than the torque applied to the rotatable member during normal motion condition of the watercraft without sharp deceleration.
14. The assembly of any one of claims 1-13, wherein an exposed area of the rotatable member is flush with the surface of the watercraft.
15. The assembly of any one of claims 1-14, wherein the retention member is devoid of a power source.
16. The assembly of any one of claims 1-15, wherein the rotatable member is configured to be rotatable in the anti-clockwise direction from the default

position, when the rotatable member is disposed on the starboard side of the watercraft.

- 5 17. The assembly of any one of claims 1-16, wherein the rotatable member is configured to be rotatable in the clockwise direction from the default position, when the rotatable member is disposed on the port side of the watercraft.
- 10 18. An apparatus comprising a pair of first and second assemblies, each of the assemblies as claimed in any one of claims 1-17, wherein the maximal rotated position of the first assembly relative to the default position is at a different angle from the rotated position of the second assembly.
- 15 19. The apparatus of claim 18, wherein a biasing strength of a biasing member of the first assembly is different from a biasing strength of a biasing member of the second assembly.
- 20 20. The apparatus of claim 18 or claim 19, wherein a stiffness of a torsional or linear spring of the first assembly is different from a stiffness of a torsional or linear spring of the second assembly.
- 25 21. A watercraft comprising the assembly or the apparatus of any one of claims 1-20.
- 30 22. A method of securing a foot of a person onto a surface of a watercraft, the method comprising:
 - providing a retention member for receiving and securing the foot of in a default position;
 - coupling the retention member to a rotatable member, said rotatable member for allowing the retention member to be rotated upon itself and about an axis substantially perpendicular to the surface of the watercraft;
 - allowing the rotatable member to rotate the retention member from the default position to a rotated position when a torque applied to the rotatable member exceeds a threshold, said rotation of the retention member allowing the foot to be dislodged from the retention member along a plane substantially parallel to the surface of the watercraft; and
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providing a stop member for preventing a further rotation of the rotatable member, when the rotatable member has rotated the retention member to a maximal rotated position.

- 5 23. The method of claim 22, wherein said rotation of the retention member allowing the foot to be dislodged from the retention member is caused by momentum of the person's body and deceleration of the watercraft.
- 10 24. The method of claim 22 or claim 23, wherein a length of the received foot in the retention member in the default position is substantially perpendicular to a direction of motion of the watercraft.
- 15 25. The method of claim 24, wherein said rotation of the retention member allows the foot to be dislodged from the retention member in a direction that is substantially in the direction of motion of the watercraft.
- 20 26. The assembly, the apparatus, the watercraft or the method of any one of claims 1-25, wherein the watercraft is selected from the group consisting of: sailboat, skiff, dinghy, catamaran, trimaran, surfboard, kitesurfing board, windsurfing board and wakeboarding board.
- 25 27. A method of securing the feet of at least two persons onto a surface of a watercraft, the method comprising:
 providing a first retention member for receiving and securing a foot of a first person in a default position;
 coupling the first retention member to a first rotatable member, said first rotatable member for allowing the first retention member to be rotated upon itself and about a first axis substantially perpendicular to the surface of the watercraft;
30 allowing the first rotatable member to rotate the first retention member from its default position to a first rotated position when a first torque applied to the first rotatable member exceeds a first threshold, said rotation of the first retention member allowing the foot of the first person to be dislodged from the first retention member along a plane substantially
35 parallel to the surface of the watercraft;

providing a first stop member for preventing a further rotation of the first rotatable member, when the first rotatable member has rotated the first retention member to a first maximal rotated position.

5 providing a second retention member for receiving and securing a foot of a second person in a default position of the second retention member;

10 coupling the second retention member to a second rotatable member, said second rotatable member for allowing the second retention member to be rotated upon itself and about a second axis substantially perpendicular to the surface of the watercraft;

15 allowing the second rotatable member to rotate the second retention member from its default position to a second rotated position when a second torque applied to the second rotatable member exceeds a second threshold, said rotation of the second retention member allowing the foot of the second person to be dislodged from the second retention member along a plane substantially parallel to the surface of the watercraft;

providing a second stop member for preventing a further rotation of the second rotatable member, when the second rotatable member has rotated the second retention member to a second maximal rotated position;

20 wherein the first rotated position is at a different angle from the second rotated position, and optionally wherein the first and second maximal rotated positions comprise the first rotated position and the second rotated position respectively.

25 28. The method of claim 27, wherein the first retention member is located nearer to a bow of the watercraft and the second retention member is located nearer to a stern of the watercraft.

30 29. The apparatus of any of claims 18-20, wherein the first assembly is located nearer to a bow of the watercraft and the second assembly is located nearer to a stern of the watercraft.