MODULAR ADAPTIVE HOLDER

FIELD

[0001] The present disclosure relates generally to adaptive holders for people with limited upper limb strength or mobility.

BACKGROUND

[0002] The following discussion of the background to the invention is intended to facilitate an understanding of the present invention only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was published, known or part of the common general knowledge of the person skilled in the art in any jurisdiction as at the priority date of the invention.

[0003] Patients who are affected by neurological conditions or hand conditions, have limited upper limb functions in strength and range of motion, and they are unable to independently perform feeding and other self-care tasks such as grooming. Neurological conditions may include stroke, Parkinson's, Motor Neuron Disease, Multiple System Atrophy, Spinal cord injury. Such patients often experience: reduced wrist and grip strength; limited active range of motion (AROM); lack of coordination and pain. Hand conditions are often orthopaedic in nature due to hand injury; elbow injury, arthritis, tendon injury peripheral nerve condition, fracture. Such patients often experience: reduced wrist and grip strength; finger stiffness; limited AROM and pain. Others such as geriatric population also may experience impairments such as: reduced upper limb grip or strength; generalized weakness; and tremors. These patients are often prescribed adaptive devices to assist feeding, grooming and other self-care tasks.

[0004] There are limited adaptive devices available. Clinicians or care givers often modify utensils and other personal items on a case-by-case basis, using spare materials available in the clinical setting, such as thermoplastic materials or home items such as velcro straps. These "homebrewed" modifications, however, are time-consuming and not sustainable in the long-term. The use of velcro straps is not sustainable due to rapid wear and tear of the materials. It is difficult to attach utensils and other items such as a comb, a toothbrush or a pen onto splinting material.

[0005] There have been attempts to make enlarged plastic handles however these work in a similar way to thermoplastic material and have the same drawbacks.

[0006] The available or disclosed holders lack range of angles at distal ends, reducing the ease of directing spoon-to-mouth or comb-to-hair motions, that can compensate for a patient's limitation.

[0007] There exists a need to create alternative adaptive devices and alleviate at least one of the aforementioned problems.

SUMMARY

[0008] An adaptive holder for people with limited upper limb strength or mobility, that can be easily adapted for a range of different uses over a wide range of motion is envisaged.

[0009] Accordingly, an aspect of the invention refers to an adaptive holder for people with limited upper limb strength or mobility comprising an opening formed of a flexible material elastically deformable to frictionally hold a utensil at one side of the holder; a connector for connecting the adaptive holder to a support collar and a locking arrangement for locking the connector to the support collar, wherein the adaptive holder is rotatable about at least one plane when it is connected to the support collar.

[0010] Another aspect of the invention refers to a method of fabricating the adaptive holder by an additive manufacturing technique.

[0011] Other aspects and features of the present invention will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] In the figures, which illustrate, by way of non-limiting examples only, embodiments of the present invention,

[0013] **Figure 1: (A)** a perspective view of an embodiment of the connected modular adaptive holder, handle and strap **(B)** an exploded view of an embodiment of the modular adaptive holder, handle and strap; **(C)** a top view of an embodiment of the modular adaptive holder, Handle and Strap; **(D)** a bottom view of an embodiment of the modular adaptive holder, Handle and Strap; **(E)** a front view of an embodiment of the modular adaptive holder, Handle and Strap; **(F)** a back view of an embodiment of the modular adaptive holder, Handle and Strap; **(G)** a right view of an embodiment of the

modular adaptive holder, Handle and Strap; **(H)** a left view of an embodiment of the modular adaptive holder, Handle and Strap;

[0014] **Figure 2: (A)** a perspective view of an embodiment of the modular adaptive holder; **(B)** a front view of an embodiment of the modular adaptive holder; **(C)** a bottom view of an embodiment of the modular adaptive holder; **(D)** a top view of an embodiment of the modular adaptive holder; **(E)** a right view of an embodiment of the modular adaptive holder; **(F)** a left view of an embodiment of the modular adaptive holder; **(G)** a back view of an embodiment of the modular adaptive holder; **(H)** a cross-sectional view through lines A--A of **Figure 2D**, **(I)** a side view of an embodiment of the modular adaptive holder wherein the outer lock is in the “locked” state.

[0015] **Figure 3: (A)** a perspective view of an embodiment of the connected modular adaptive holder, handle and strap; **(B)** a front view of an embodiment of the connected modular adaptive holder and handle; **(C)** an exploded view of an embodiment of the connected modular adaptive holder, handle and strap; **(D)** a top view of an embodiment of the connected modular adaptive holder, handle and strap; **(E)** a bottom view of an embodiment of the connected modular adaptive holder and handle; **(F)** a right view of an embodiment of the connected modular adaptive holder and handle; **(G)** a left view of an embodiment of the connected modular adaptive holder and handle; **(H)** a back view of an embodiment of the connected modular adaptive holder handle and strap; **(I)** a south-east isometric view of an embodiment of the connected modular adaptive holder and handle.

[0016] **Figure 4: (A)** a perspective view of an embodiment of the modular adaptive holder; **(B)** a bottom view of an embodiment of the modular adaptive holder; **(C)** a front view of an embodiment of the modular adaptive holder; **(D)** a side view of an embodiment of the modular adaptive holder; **(E)** a top view of an embodiment of the modular adaptive holder; **(F)** a cross-sectional view through lines B--B of **Figure 4E**;

[0017] **Figure 5: (A)** a top view of an embodiment of the Handle; **(B)** a cross-sectional view through lines C--C of **Figure 5A**.

[0018] **Figure 6: (A)** a perspective view of an embodiment of the Strap; **(B)** a top view of an embodiment of the Strap, and **(C)** a side view of an embodiment of the Strap.

DETAILED DESCRIPTION

[0019] Throughout this document, unless otherwise indicated to the contrary,

the terms “comprising”, “consisting of”, “having” and the like, are to be construed as non-exhaustive, or in other words, as meaning “including, but not limited to”.

[0020] Furthermore, throughout the document, unless the context requires otherwise, the word “include” or variations such as “includes” or “including” will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

[0021] Unless defined otherwise, all other technical and scientific terms used herein have the same meaning as is commonly understood by a skilled person to which the subject matter herein belongs.

[0022] According to an embodiment there is an adaptive holder for people with limited upper limb strength or mobility comprising an opening formed of a flexible material elastically deformable to frictionally hold a utensil at one side of the holder; a connector for connecting the adaptive holder to a support collar and a locking arrangement for locking the connector to the support collar, wherein the adaptive holder is rotatable about at least one plane when it is connected to the support collar.

[0023] Having the opening formed of a flexible material elastically deformable to frictionally hold a utensil allows a wide variety of utensils of slightly varying shapes or sizes to be inserted into the opening. This unique soft grip opening accommodates utensils and other daily living items and permits for the adaptive holder to be easily adapted for a range of different uses. Utensils may include spoon, fork, pen, pencil, paintbrush, comb, toothbrush, razor basic grooming items writing equipment, pointer for keyboard/ screen or any other implement that generally requires fine motor movement of the hand to grasp and use.

[0024] Having the adaptive holder is rotatable about at least one plane when it is connected to the support collar allows the adaptive holder to easily be adapted over a wide range of motion. Being rotatable about at least one plane when it is connected to the support collar increases the range of angles at distal ends, increasing the ease of directing spoon-to-mouth or comb-to-hair motions, that can compensate for a patient’s limitation. Having the locking arrangement provides the adjusted position to be stabling held in place.

[0025] The holder helps clinicians to improve availability of feeding adaptive devices, accommodate various identified disabilities and weaknesses, while ensuring maximal usability for patients. The device may be used to easily meet patients’ needs in

self-care tasks.

[0026] In various embodiments, the connecter comprises a matching shaped portion configured to match with the support collar, wherein when the connector is connected to the support collar the matching shape of the connector is inserted into the support collar.

[0027] Where the shaped portion of the connector is matching with the shape of the support collar it allows the connector and support collar to be easily connected with gross motor movements not requiring fine motor movement. This may compensate for a patient's upper limb strength or mobility limitations. It has the further advantage that the adaptive holder is easily interchangeable in a modular fashion. Modularity of usages enables new parts for different identified uses. In this way adaptive holders with openings of different sizes may be used. When a user wants to use a paintbrush or a pen an adaptive holder with a very small opening may be connected to the support collar, when a user wants to use a fork or spoon an adaptive holder with a slightly larger opening may be connected to the support collar, and when a user wants to use a toothbrush or comb an adaptive holder with an opening slightly larger again may be connected to the support collar. This has the advantage of being easily adapted for a range of different uses.

[0028] In various embodiments, the shaped portion of the connector and the matching shape of the support collar is polygonal such as a square, a hexagon, an octagon, a decagon, or a twelve-sided polygon. Having matching shapes portions of this type make the adaptive holder more easily rotatable about at least one plane when it is connected to the support collar.

[0029] In various embodiments, the locking arrangement comprises at least one protruding tab on the connector engageable with at least one recess on an inner wall of the support collar.

[0030] The inner lock has the advantage of providing a secure connection that is also easily disengaged with rotation to allow adjustment of the positioning of the holder or to change to a different holder. Locking, rotational movement and disengagement are able to be achieved with gross motor movements that require less strength.

[0031] In various embodiments, the locking arrangement comprises an outer lock pivoted adjacent the connector wherein when the connector is connected to the support collar, the outer lock is pivotable to a locking position where the outer lock adjoins

the side of the housing. Refer to Figure 2I for the “locked state” of the outer lock.

[0032] In various embodiments, the outer lock can be used in combination with the inner lock to provide a more secure locking arrangement. Alternatively, in various embodiments, the outer lock can be used as the only locking arrangement. The outer lock has the advantage of providing a secure connection that is also easily disengaged to allow adjustment of the positioning of the holder or to change to a different holder. Locking, and disengagement are able to be achieved with gross motor movements that require less strength.

[0033] In various embodiments, the opening of the adaptive holder comprises a first opening and a second opening. In this way the first and second opening may be of different sizes. When the first opening is smaller than the second opening then a user will be able to choose which opening to use depending on the utensil they want to use. A paintbrush or a pen may require a small opening a fork or spoon may require a slightly larger opening and a toothbrush, comb or other grooming utensils may require an opening slightly larger again. This has the advantage of being easily adapted for a range of different uses.

[0034] In various embodiments, the first and second openings are formed in a top portion of the holder distanced from the connector via an L-shaped connector.

[0035] In various embodiments, a ball joint is located between the L-shaped connector and the connector. This has the advantage of permitting the adaptive holder to be rotatable about a wide range of planes when it is connected to the support collar and increases the range of angles at distal ends, increasing the ease of directing spoon-to-mouth or comb-to-hair motions, that can compensate for a patient’s limitation.

[0036] In various embodiments, the ball joint comprises a ball seat, a push pin and a housing that works together to confine the movement of the ball joint when the locking arrangement is in a locked position.

[0037] In various embodiments, the locking arrangement is the outer lock as described herein above and the ball joint is confined in a locked position when the outer lock is pivoted about the pivot point to a locking position and the outer lock is adjoins the housing. This translates the rotational force from the outer lock using a cam to a horizontal linear force at the push pin. The push pin acts as a wedge to drive the ball seat vertically compressing the ball joint against the housing. The compression prevents the ball joint

from rotating resulting in locking the holder at a fixed position. Once the lock is released the compressive force in ball joint will revert the ball seat and push pin back to their original position causing the ball joint to be free to rotate again allowing adjustment to another position. Locking, and disengagement are able to be achieved with gross motor movements and minimal strength.

[0038] In various embodiments, the housing contains screw threads where adjustable to vary the compression of the ball joint by limiting the space within which the ball joint is able to move or rotate. In various embodiments, the housing is used as sustainable adjustment when the components in the ball joint wear out.

[0039] In various embodiments, the holder comprises a hard outer shell with a soft insert, wherein the opening formed of a flexible material elastically deformable to frictionally hold a utensil is formed within the soft insert.

[0040] In various embodiments, the adaptive holder further comprises the support collar. In various embodiments, the adaptive holder is connected to the support collar.

[0041] In various embodiments, the support collar comprises a handle. An enlarged handle allows users with weak grip strength to grip on the device with gross motor movements without requiring fine motor movements compensating for a patient's limitation.

[0042] In various embodiments, the handle comprises a hollow cavity. The hollow cavity 19 of this embodiment depicted in Figure 5B, allows small items or weights that help users with unstable hand conditions such as Parkinson's to hold the handle more stably when connected to the adaptive holder.

[0043] In various embodiments, the adaptive holder further comprises a strap attached to the handle. The strap may prevent the device from slipping out of the user's hand.

[0044] In various embodiments, the strap comprises, an elastic handle engaging ring that fits in a recess adjacent the support collar in the handle; and a plurality of strap adjustment slots distal from the elastic handle engaging ring wherein each of strap adjustment slots is able to engage a knob on the handle distal from the support collar. Referring to Figures 3A and 3B, the elastic handle engaging ring 23 is designed to fit snugly into the recess adjacent the support collar 11 while the adjustable slots 21 enable users to adjust the tightness of the strap onto knob 13.

[0045] In various embodiments, the strap comprises a ring for a finger hold between the elastic handle engaging ring and the plurality of strap adjustment slots. The finger hold may help a user with weak grip to loop their fingers through and enable them to easily pull the hand up to the palm to secure the device onto their hand.

[0046] In various embodiments, the handle has an indent under the knob forming a semi-circular base 25 on the handle. The indent and the knob together form a very wide opening that narrows to small space at the base where they meet, see for example the embodiment in figures 3F and 3G. The wide opening permits the adjustment slots to more easily engage with the knob with less strength or motor movement compensating for a patient's limitation.

[0047] In various embodiments, the strap comprises bumps adjacent to the plurality of strap adjustment slots. The bumps 20 may facilitate this process of adjusting the strap by providing better grip to the strap for fastening.

[0048] According to another embodiment there is a method of fabricating the adaptive holder by an additive manufacturing technique.

[0049] There are many methods and devices available for additive manufacturing or three-dimensional printing (3D printing). Additive manufacturing or 3D printing may improve availability, accommodate to many disabilities and weaknesses, while ensuring affordability and useability for patients. 3D printing may allow for semi-customizable adjustments to be made to the device depending on the size of the patient's hand or the level of upper limb strength and mobility.

[0050] In various embodiments, the adaptive holder is 3D printed with polymers. In various embodiments, the flexible material elastically deformable to frictionally hold a utensil and or strap may be printed from a polymer having a Young's modulus of elasticity of 2GPa or less. In various embodiments, the flexible material elastically deformable to frictionally hold a utensil being printed from a material selected from the group comprising or consisting of thermoplastic elastomers (TPE), polypropylene such as polyethylene (low density) (LDPE) or polyethylene (high density) (HDPE), Chlorinated polyether, polytetrafluoroethylene, and polystyrene foam. Of course, any material known to be flexible, elastic and deformable would also be suitable.

[0051] In various embodiments, other parts of the adaptive holder and handle may be printed from a harder polymer. Polymers have the advantage of being easy to

clean.

[0052] In various embodiments, the other parts of the adaptive holder and handle may be printed from a material selected from the group comprising or consisting of polylactic acid (PLA) Acrylonitrile Butadiene Styrene (ABS) plastics, metal, resin, polyamide, and high impact polystyrene. Where the device is made of a sustainable material it will have the advantage of reduced wear and tear.

[0053] In various embodiments, the flexible material elastically deformable to frictionally hold a utensil and or strap may be printed from soft polylactic acid (soft PLA) and the other parts of the adaptive holder and handle may be printed from polylactic acid (PLA). Such biopolymers have the advantage of being biodegradable.

[0054] Referring to Figures 1 and 2, in an embodiment the adaptive holder device 22 comprises a top portion 1 which is made of soft material that is flexible elastically deformable where it has two different through openings a first opening 2 and a second opening 3. The first opening 2 is adapted to accommodate utensils such as spoons or forks while the second opening 3 is adapted to accommodate utensils such as standard sized daily items including comb and toothbrush. A ball-joint 5 is located in a housing 27 distanced from the top portion 1. The ball-joint 5 permits the top portion 1 to be rotatable 360° to enabled items in the holder 22 to reach different angles and positions. The ball-joint 5 is distanced from the top portion by an L-shaped connector 4, connected to the top portion 1 and to the ball-joint 5. The L-shaped connector 4 may also permit better range of motion for the holder 1 to rotate. The connector 10 of the adaptive holder is hexagon shape, matching the shape of the support collar 12 of the handle 7. The locking arrangement comprises both an inner lock comprising at least one protruding tab 17 on the connector 10 engageable with at least one recess 18 on an inner wall of the support collar 12 and an outer lock 6 pivoted 28 adjacent a connector 10 wherein when the connector 10 is connected to the support collar 12 the outer lock 6 is pivotable to a locking position and the outer lock 6 adjoins the side 31 of the housing 27. By initially pushing up until the outer lock 6 starts to pivot about the pivot point lock 28, the outer lock 6 adjoins the side of the housing 27 and snap fits to provide a function of locking the ball-joint 5 so as to fix the current position of the top portion 1 to enable user to use the utensils stably. This forms a cam linked ball joint 5 with flip-outer lock 6 mechanism with a quick release ball joint 5 that has an outer lock easily locked and unlocked, to allow changes of angle for the circular and horizontal motions, to reach to desired part of the body. A ball seat 26 is compressed when the outer lock 6 is pivoted about the pivot point 28 to a locking position and the outer lock 6

adjoins the side of the housing 27. The push pin 29 is curved . The compression from the ball seat 26 prevents the ball joint 5 from rotating resulting in locking the holder at a fixed position. Once the outer lock 6 is released the ball joint 5 is free to rotate again within the housing 27 allowing adjustment to another position. Releasing the outer lock 6 allows the ball-joint 5 to unlock enabling top portion 1 to move again thus allowing for further adjustment of the top portion's position. Users will need to slide their hands in between handle 7 and strap 8 while facing their palm towards enlarged handle 7. Enlarged handle 7 will be able to allow users with weak grip strength to grip on the body while soft strap 8 will prevent the device from slipping out of the user's hand. With an addition of hole 9 help user with weak grip to loop their fingers through and enable them to easily pull the hand up to the palm to secure the device onto their hand.

[0055] Referring to Figures 3A to 5B, in an embodiment the adaptive holder device 22 comprises 2 different materials where it is made up of and hard outer shell 14 and soft insert 16. Within the soft insert 16, opening 15 is flexible elastically deformable to expand and allow utensil to fit snugly inside. The connector 10 is made of a 12-sided hex connector 10 to enable 12 different orientations when connected the support collar 12. The locking arrangement comprises an inner lock comprising at least one protruding tab 17 on the connector 10 engageable with at least one recess 18 on an inner wall of the support collar 12. This forms a twist-inner lock accommodative fit. The locking arrangement makes the connection secure.

[0056] Referring to Figure 5B, in various embodiment empty cavity 19 in the handle 7 allows small items or weights that help users with unstable hand conditions such as Parkinson's to hold the handle more stably when connected with an adaptive holder 22.

[0057] Referring to Figure 6, in various embodiment the strap 8 comprises a handle engagement ring 23 that may be stretched over the support collar 12 of the handle to fit snugly in the recess 11 adjacent the support collar 12. The recess 11 adjacent the support collar 12 extends around the circumference of the handle 7. Distal from the handle engagement ring 23 on the strap 8, adjustment slots 21 enable users to adjust the tightness of the strap onto knob 13. In various embodiments, the handle 7 has an indent 24 under the knob 13 forming a semi-circular base 25 on the handle 7. The indent 24 and the knob 13 together form a very wide opening that narrows to small space at the base where they meet, see for example the embodiment in figures 3F and 3G. The wide opening permits the adjustment slots 21 to more easily engage with the knob 13 with less strength or motor movement compensating for a patient's limitation. Bumps 20 located adjacent the end of the

strap 8 nearest the adjustment slots 21 facilitate this process by providing better grip to the strap 8 for fastening. Once the strap 8 length has been fixed for the user, the process of fastening does not have to be repeated, instead, user can easily wear the strap 8 by using the finger ring 9 to pull the strap 8 to the back of their hand. The ergonomic strap 8 may be 3D printed. The ergonomic adjustable strap 8 is able to match different hand sizes and promote independency in wearing the device. The strap encourages self-reliance for independent wearing and adjusting the universal adaptive holder.

[0058] In various embodiment the connector 10 is 8-sided, shaped to fit a matching shape of the support collar 12 to enable 8 different orientations when connected to the support collar 12. handles with different adaptors at 8 possible angles.

[0059] 3D-printed adaptive device that can help improve availability for clinical use, accommodate to many disabilities and weaknesses, while ensuring affordability and maximal usability for patients.

[0060] The method of fabricating the adaptive holder by an additive manufacturing technique permits modifiable of the 3D print file to fit specific requirements of client(s) or patients.

[0061] It should be further appreciated by the person skilled in the art that variations and combinations of features described above, not being alternatives or substitutes, may be combined to form yet further embodiments falling within the intended scope of the invention.

[0062] As would be understood by a person skilled in the art, each embodiment, may be used in combination with other embodiment or several embodiments.

[0063] Components in the Drawings

[0064] 1 – top portion

[0065] 2 – first soft grip opening

[0066] 3 – second soft grip opening

[0067] 4 – L shaped connector

[0068] 5 – ball joint

[0069] 6 – outer lock

[0070] 7 – handle

[0071] 8 – strap

[0072] 9 – ring for finger

[0073] 10 –connector

[0074] 11 – outer recess

[0075] 12 – support collar

[0076] 13 – strap engaging knob

[0077] 14 – outer shell

[0078] 15 – soft grip opening

[0079] 16 – soft insert

[0080] 17 – protruding tab

[0081] 18 – recess on the inner wall

[0082] 19 – hollow cavity

[0083] 20 – bumps

[0084] 21 – strap adjustment slots

[0085] 22 – adaptive holder

[0086] 23 – handle engagement ring

[0087] 24 – handle indent

[0088] 25 – semicircular base

[0089] 26 – ball seat

[0090] 27 – housing

[0091] 28 - pivot for the outer lock

[0092] 29 – push pin

Claims

1. An adaptive holder for people with limited upper limb strength or mobility comprising an opening formed of a flexible material elastically deformable to frictionally hold a utensil at one side of the holder; a connector for connecting the adaptive holder to a support collar and a locking arrangement for locking the connector to the support collar, wherein the adaptive holder is rotatable about at least one plane when it is connected to the support collar.

2. The adaptive holder according to claim 1, wherein the connecter comprises a matching shaped portion configured to match with the support collar, wherein when the connector is connected to the support collar the matching shape of the connector is inserted into the support collar.

3. The adaptive holder according to claim 1 or 2, wherein the locking arrangement comprises at least one protruding tab on the connector engageable with at least one recess on an inner wall of the support collar.

4. The adaptive holder according to any one of claims 1 - 3, wherein the locking arrangement comprises an outer lock pivoted adjacent the connector wherein when the connector is connected to the support collar the outer lock is pivotable to a locking position where the outer lock is juxtaposed against the side of the housing.

5. The adaptive holder according to any one of claims 1-4, wherein the opening comprises a first opening and a second opening.

6. The adaptive holder according to claim 5, wherein the first and second opening are formed in a top portion of the holder distanced from the connector via an L-shaped connector.

7. The adaptive holder according to claim 6, wherein a ball joint is located between the L-shaped connector and the connector.

8. The adaptive holder according to claim 7, wherein the ball joint comprises a ball seat, push pin and a housing wherein the movement of the ball joint is confined when the locking arrangement is in a locked position.

9. The adaptive holder according to claim 8, wherein the the housing contains screw threads.

10. The adaptive holder according to any one of claims 1-5, wherein the holder comprises a hard outer shell with a soft insert, wherein the opening formed of a flexible material elastically deformable to frictionally hold a utensil is formed within the soft insert.

11. The adaptive holder according to any one of claims 1-8, further comprising the support collar.

12. The adaptive holder according to any one of claims 1-9, wherein the support collar comprises a handle.

13. The adaptive holder according to claim 11, wherein the handle comprises a hollow cavity.

14. The adaptive holder according to claim 11 or 12, further comprising a strap attached to the handle.

15. The adaptive holder according to claim 13, wherein the strap comprises,

a. an elastic handle engaging ring that fits in a recess adjacent the support collar in the handle; and

b. a plurality of strap adjustment slots distal from the elastic handle engaging ring wherein each of strap adjustment slots is able to engage a knob on the handle distal from the support collar.

16. The adaptive holder according to claim 13 or 14, wherein the strap comprises a ring for a finger hold between the elastic handle engaging ring and the plurality of strap adjustment slots.

17. The adaptive holder according to claim 14, wherein the handle has an indent under the knob forming a semi-circular base on the handle.

18. The adaptive holder according to any one of claims 14-16, wherein the strap comprises bumps adjacent to the plurality of strap adjustment slots.

19. A method of fabricating the adaptive holder according to any one of claims 1 – 17, wherein the adaptive holder is formed by an additive manufacturing technique.