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SWIMMING INSTRUCTION SYSTEM WITH OPTICAL PROJECTOR

Abstract

A swimming instruction system including a buoyant kickboard, an optical projector disposed on the buoyant kickboard to project user-readable information onto the buoyant kickboard, a limb piece comprising a limb sensor, and a controller to receive sensor data from the wrist piece and/or the ankle piece and transmit user-readable information to the optical projector. The swimming instruction system analyzes sensor data from limb sensors to detect a limb motion, compare a detected limb motion with a predicted limb motion, generate a user advice, transmit to the optical projector user-readable information including the user advice, and display the user advice using the optical projector. The swimming instruction system is used in a method of teaching a user to swim.

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Background/Summary

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present disclosure relates to a swimming instruction system that includes an optical projector.

Discussion of the Background

[0002] The “background” description provided herein is for the purpose of generally presenting the context of the disclosure. Work of the presently named inventors, to the extent it is described in this background section, as well as aspects of the description which may not otherwise qualify as prior art at the time of filing, are neither expressly nor impliedly admitted as prior art against the present invention.

[0003] Drowning is one of the leading causes of accidental death among children and remains a significant cause of death for adults. For all ages, the current annual global estimate is 295,000 drowning deaths. Learning to swim has been found to be an effective drowning prevention strategy and has been proposed by the World Health Organization (WHO) as one of ten key strategies for global drowning prevention.

[0004] Typically, swimming instruction is taught using an instructor or coach. Instruction may be provided through multiple delivery modes including through schools, within vacation programs, and through private instruction. However, these conventional approaches have significant disadvantages. Limiting instruction to schools places large economic burdens on schools and students to have the necessary equipment and curriculum. Vacation programs and private instructions are typically very expensive. In order to bring the costs of hiring coaches or instructors, group instruction is typically used. However, group instruction dramatically limits the individual feedback and attention that any given swimming student can receive. There is a direct trade-off between the cost and the individual instruction. The most efficient instruction would provide each swimming student with feedback and instructions tailored to their exact needs, such as specific feedback on motions, posture correction, and the like.

[0005] Accordingly, it is an objective of the present disclosure to providing a system and method for teaching a person to swim by providing individualized feedback.

SUMMARY OF THE INVENTION

[0006] The present disclosure relates to a swimming instruction system, comprising a buoyant kickboard, an optical projector disposed on the buoyant kickboard configured to project user-readable information onto the buoyant kickboard, a limb piece comprising a limb sensor, and a controller configured to receive sensor data from the limb sensor and transmit user-readable information to the optical projector.

[0007] In some embodiments, the buoyant kickboard comprises a polymer which is at least one selected from the group consisting of ethylene-vinyl acetate, polypropylene, polystyrene, polyethylene, polyvinyl chloride, and thermoplastic polyurethane.

[0008] In some embodiments, the buoyant kickboard has a substantially flattened shape that includes a distal end that is convex and a proximal end that is concave.

[0009] In some embodiments, the buoyant kickboard has a distal end groove disposed in the distal end and oriented substantially parallel to a length of the buoyant kickboard from the distal end to the proximal end.

[0010] In some embodiments, the limb piece comprising a limb sensor is at least one selected from the group consisting of a wrist piece comprising a wrist sensor and a wrist strap and an ankle piece comprising an ankle sensor and an ankle strap.

[0011] In some embodiments, the optical projector is contained within a projector module disposed

on a distal end of the buoyant kickboard.
[0012] In some embodiments, the projector module is configured to be removably attached to the buoyant kickboard.
[0013] In some embodiments, the projector module is configured to be secured within a distal end groove disposed in the distal end and oriented substantially parallel to a length of the buoyant kickboard from the distal end to the proximal end.
[0014] In some embodiments, the controller is contained within the projector module.
[0015] In some embodiments, the projector module further comprises a wireless communication module connected to the controller.
[0016] In some embodiments, the system further comprises a user input device configured to receive user input and transmit the user input to the controller.
[0017] In some embodiments, the optical projector comprises a user input sensor configured to receive user input and transmit the user input to the controller.
[0018] In some embodiments, the swimming instruction system further comprises a user identification badge disposed on the limb piece and encoding user-identifying information, and an identification badge sensor disposed on the optical projector, wherein the identification badge sensor is configured to detect the user identification badge and decode the user-identifying information.
[0019] In some embodiments, the swimming instruction system further comprises an earpiece configured to be worn on an ear of a user and to receive auditory information from the controller and play the auditory information for the user.
[0020] In some embodiments, the controller is configured to analyze sensor data from limb sensor to detect a limb motion, compare a detected limb motion with a predicted limb motion, generate a user advice, transmit to the optical projector user-readable information including the user advice; and display the user advice using the optical projector.
[0021] In some embodiments, the limb sensor is a wrist sensor, the detected limb motion is a detected arm motion, and the predicted limb motion is a predicted arm motion.
[0022] In some embodiments, the limb sensor is an ankle sensor, the detected limb motion is a detected leg motion, and the predicted limb motion is a predicted leg motion.
[0023] In some embodiments, the buoyant kickboard comprises a plurality of detachable sections.
[0024] The present disclosure also relates to a method of teaching a user to swim using the swimming teaching system, the method comprising analyzing sensor data from the limb sensor to detect a limb motion, comparing a detected limb motion with a predicted limb motion, generating a user advice, and displaying the user advice using the optical projector.
[0025] In some embodiments, the method further comprises producing an auditory advice audible to a user.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0026] FIGS. **1**A-**1**C show the buoyant kickboard according to an exemplary embodiment of the present disclosure;
[0027] FIGS. **2**A-**2**C show schematic depictions of a projection module according to an exemplary embodiment of the present disclosure where FIG. **2**A shows a side-on view, FIG. **2**B shows a front-on view, and FIG. **2**C shows an end-on view;
[0028] FIG. **2**D shows a rendering of a projection module according to an exemplary embodiment of the present disclosure in a three-quarters view;
[0029] FIG. **2**E shows a blown-out view of the components of the exemplary projection module;
[0030] FIGS. **3**A-**3**C show schematic depictions of a limb piece **120** according to an exemplary

embodiment of the present disclosure where FIG. **3**A shows a side-on view, FIG. **3**B shows an end-on view, and FIG. **3**C shows a top-down view;
[0031] FIG. **3**D a rendering of a limb piece according to an exemplary embodiment of the present disclosure presented in a three-quarters view.
[0032] FIG. **3**E shows a blown-out view of the components of an exemplary limb piece.
[0033] FIG. **4** shows a depiction of an earpiece according to an exemplary embodiment of the present disclosure;
[0034] FIGS. **5**A-**5**F show images of a user using the system in a method of swimming instruction, according to an exemplary embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE INVENTION

[0035] In the following description, it is understood that other embodiments may be utilized and structural and operational changes may be made without departure from the scope of the present embodiments disclosed herein.

Definitions

[0036] As used herein the words “a” and “an” and the like carry the meaning of “one or more.”
[0037] As used herein, the terms “optional” or “optionally” means that the subsequently described event(s) can or cannot occur or the subsequently described component(s) may or may not be present (e.g., 0 wt. %).
[0038] According to a first aspect, the present disclosure relates to a swimming instruction system, comprising a buoyant kickboard, an optical projector disposed on the buoyant kickboard configured to project user-readable information onto the buoyant kickboard, a limb piece comprising a limb sensor, and a controller configured to receive sensor data from the limb sensor and transmit user-readable information to the optical projector.
[0039] In some embodiments the buoyant kickboard has a substantially flattened shape, such as an escutcheon shape with a convex bottom portion. In some embodiments, the substantially flattened shape includes a top surface and a bottom surface. In preferred embodiments, the buoyant kickboard is configured to be used in an intended training orientation such that the top surface faces away from the water and the bottom surface is in the water. In some embodiments, the substantially flattened shape includes a distal end and a proximal end. The distal end refers to an end which is farther from the user when in the intended training orientation and may also be referred to as a “front end”, “front”, or other similar term. The proximal end refers to an end which is closer to the user when in the intended training orientation and may also be referred to as a “back end”, “rear,” or other similar term. A direction running from the proximal end to the distal end can be referred to as a “longitudinal” direction or other similar term and can be associated with a length of the buoyant kickboard. A direction running perpendicular to the longitudinal direction (e.g., from a left side to a right side of the buoyant kickboard) can be referred to as a “horizontal” direction or other similar term and can be associated with a width of the buoyant kickboard.
[0040] In some embodiments, the bottom surface is substantially flat. In some embodiments, the bottom surface may have a convex configuration. In some embodiments, the convex configuration can be defined by a curve oriented in a horizontal (i.e., side-to-side) orientation. That is, the bottom surface can be substantially flat along a direction from proximal end to the distal end but have a curve along a direction perpendicular to the direction from the proximal end to the distal end. In some embodiments, the convex configuration can be defined by a “V-shape” oriented in a side-to-side orientation. That is, the bottom surface can be substantially flat along a direction from proximal end to the distal end but have a V-shape along a direction perpendicular to the direction from the proximal end to the distal end. In such embodiments, either the V-shape or the curve are oriented such that a midpoint or peak of the V-shape or curve is located at a midpoint of the bottom surface in the horizontal direction. In some embodiments, the bottom surface can have a curve along a longitudinal direction of the buoyant kickboard. In some embodiments, a curve on or associated with the bottom surface is associated with a difference in a thickness of the buoyant

kickboard. That is, the curve may be accompanied by or formed by portions of the buoyant kickboard having a smaller thickness than other portions of the buoyant kickboard.
[0041] In some embodiments, the top surface is substantially flat. In some embodiments, a portion of the top surface is substantially flat. Such a portion may be particularly useful for providing a convenient surface for projecting visual information onto the top surface.
[0042] In some embodiments, the distal end of the buoyant kickboard is convex. In such embodiments, the convex distal end can be or include a curve or pointed portion. Such a curve or pointed portion is preferably oriented to be symmetrical about a midline of the buoyant kickboard in the horizontal direction. Preferably, a distalmost point of the curve or pointed portion is located along the midline of the buoyant kickboard. In some embodiments, the proximal end is concave. In such embodiments, the concave proximal end can be or include a curve or pointed portion. Such a curve or pointed portion is preferably oriented to be symmetrical about a midline of the buoyant kickboard in the horizontal direction. In some embodiments, the proximal end is not concave. In some embodiments, the proximal end is substantially flat along the horizontal direction.
[0043] In some embodiments, the buoyant kickboard has a distal end groove disposed in the distal end and oriented substantially parallel to a length of the buoyant kickboard from the distal end to the proximal end. That is, the distal end groove is oriented along the length or longitudinal direction of the buoyant kickboard.
[0044] In some embodiments, the buoyant kickboard includes gripping features. Such gripping features can include or take the form of, for example, indentations sized and configured to receive a user's hand or fingers, openings or cut-outs sized and/or configured to receive a user's hand or fingers, raised features such as bumps or ridges, or combinations of these. The gripping features may be advantageous for allowing a user to conveniently and/or securely grip the buoyant kickboard. The presence of the gripping features may increase the security of a user's grip or control of the buoyant kickboard while in use. In some embodiments, the gripping features are located on any or all of the top surface, the bottom surface, and a side surface of the buoyant kickboard. In some embodiments, the gripping features are located on a lateral portion of the buoyant kickboard. The lateral portion is a portion located away from the midline of the buoyant kickboard described above.
[0045] In some embodiments, the buoyant kickboard includes a securing feature coupled to or disposed on the top surface. In some embodiments, the securing feature is configured for securing portions of a swimmer's hands, arms, and/or torso against the top surface of the buoyant kickboard while using with the buoyant kickboard in intended training position. In some embodiments, the securing feature is in the form of a strap configured to pass over the top of a user's hands and/or arms when holding the buoyant kickboard in the intended training orientation. In some embodiments, the securing feature is in the form of a strap configured to pass around a user's torso and/or waist when securing the buoyant kickboard in the intended training orientation. In some embodiments, the strap is secured using a hook-and-loop fastener, a hook-and-hook fastener, and/or a slidingly engaging fastener.
[0046] In some embodiments, the buoyant kickboard comprises a plurality of detachable sections. That is, the buoyant kickboard is formed from or includes two or more sections which are configured to be reversibly attached to one or more other sections. In some embodiments, the buoyant kickboard comprises two or more sections connected along the longitudinal direction. In some embodiments, the buoyant kickboard comprises a proximal section and a distal section. When the buoyant kickboard is positioned in the intended training position, the proximal section is located closer to the user and the distal section is located farther from the user. In such an embodiment, the proximal section can include a securing feature configured to secure a user's torso and/or waist to the buoyant kickboard. In some embodiments, the intended training position has the user substantially lay on the buoyant kickboard or a proximal section thereof. In such an embodiment, the user can use the buoyant kickboard without having to hold it with their hands.

That is, the user can be partially supported by the buoyant kickboard and can see the top surface of the buoyant kickboard while leaving the user free to use their arms to swim. In some embodiments, the detachable sections are connected by securing to a connection point included on another section. That is, each section can include a connection point that allows for an additional section or sections to be secured to the section in question. In some embodiments, the connection point can be or include a groove. Such a groove can be disposed on the proximal end of the section or buoyant kickboard. Such a groove can be referred to as a “proximal end groove” or other similar term. In some embodiments, the connection point can be or include an indentation or hole which passes through the buoyant kickboard or section. In such embodiments, a corresponding attachment structure can be disposed within the indentation or hole to provide a connection between the sections. In general, the attachment or connection can be made by any suitable structure or feature known to one of ordinary skill in the art. Examples of such structures or features for connecting sections include, but are not limited to snap fits, bands, ropes, clips, hook-and-loop fasteners, and the like. In some embodiments, the structures or features for connecting sections allow for flexing or pivoting between sections. In some embodiments, the structures or features for connecting sections do not allow for flexing or pivoting between sections.

[0047] In some embodiments, the buoyant kickboard comprises a distal end groove disposed in the distal end and oriented substantially parallel to a length of the buoyant kickboard from the distal end to the proximal end. That is, the distal end groove is oriented along the longitudinal direction. In some embodiments, the distal end groove is disposed substantially along a midline of the buoyant kickboard.

[0048] In some embodiments, the buoyant kickboard is formed from any suitable material or materials including, but not limited to, a polymeric material such as a foam, a rubber, a plastic, and combinations thereof. In some embodiments, the buoyant kickboard comprises a polymer which is at least one selected from the group consisting of ethylene-vinyl acetate, polypropylene, polystyrene, polyethylene, polyvinyl chloride, and thermoplastic polyurethane.

[0049] In some embodiments, the limb piece comprising a limb sensor is at least one selected from the group consisting of a wrist piece comprising a wrist sensor and a wrist strap and an ankle piece comprising an ankle sensor and an ankle strap. In some embodiments, the wrist sensor is configured to sense a wrist or arm position and/or motion. The wrist sensor can also transmit the wrist or arm position to the controller as described below. In some embodiments, the ankle sensor is configured to sense an ankle or leg position and/or motion. The ankle sensor can also transmit the ankle or leg position to the controller as described below. In general, the wrist strap can be any suitable wrist strap. Similarly, the ankle strap can be any suitable ankle strap. The wrist and/or ankle strap can be configured to secure the wrist or ankle sensor as appropriate. In some embodiments, the wrist and/or ankle strap is configured to encompass an entirety of the wrist or ankle as appropriate. Such a strap can be secured using any suitable fastening or securing mechanism. Examples of such mechanisms include, a clip, a clasp, a buckle, a cam lock, a hook-and-loop fastener, a hook-and-hook fastener, and/or a slidingly engaging fastener. In some embodiments, the wrist and/or ankle strap is configured to encompass only a portion of the wrist or ankle as appropriate. In some embodiments, the strap can be adjustable. That is, a length of the strap can be changed and/or the strap can be secured in a different position to accommodate limbs of different sizes. For example, the strap can include a plurality of fastening structures (e.g., snaps, loops, slots, indentations, etc.) arranged at different positions along a length of the strap. The plurality of fastening structures can allow the strap to be securely fastened around limbs of various sizes. In some embodiments, the strap is configured to not encompass an entirety of the wrist or ankle as appropriate.

[0050] In some embodiments, the strap can be formed from a stiff but flexible material that is capable of flexing to allow the user to place the limb sensor on their limb. In some embodiments, the wrist and/or ankle strap is formed from a metal or stiff polymer band coated with a body-safe

material. A body-safe material is any material which is generally recognized as safe for contact with the skin, preferably the skin of the ear and ear canal. A body-safe material may be hypoallergenic. Examples of materials suitable for forming the contact structures include, but are not limited to foams, rubbers, polymers, elastomers, and the like. Specific examples of suitable materials include, but are not limited to polyisoprene, polybutadiene, chloroprene, neoprene, butyl rubber, styrene-butadiene rubber, nitrile rubber, ethylene polypropylene rubber, epichlorohydrin rubber, acrylic rubber, silicone rubber, fluorosilicone rubber, fluoroelastomers such as FKM and FEPM, perfluoroelastomers such as FFKM, polyether block amides, ethylene-vinyl acetate, silicone elastomers such as polydimethylsiloxane (PDMS) or other linear polysiloxanes and network polysiloxanes such as those present in silicone resins, EPDM rubber, polyvinylchloride foam, polyurethane foam, latex foam, and combinations of these.

[0051] In some embodiments, the system includes an upper arm piece. In general the upper arm piece can be similar to the wrist piece or ankle piece described above. The upper arm piece can be configured to be disposed on or worn on a user's upper arm. That is, the upper arm piece can be located at some position between the user's elbow and shoulder. The upper arm piece can be useful in determining an arm motion of the user.

[0052] In some embodiments, the system includes an upper leg piece. In general the upper leg piece can be similar to the wrist piece or ankle piece described above. The upper leg piece can be configured to be disposed on or worn on a user's upper leg or thigh. That is, the upper leg piece can be located at some position between the user's hip and knee. The upper leg piece can be useful in determining a leg motion of the user.

[0053] In general, the limb sensor can be or include any suitable sensor. Examples of such sensors include, but are not limited to flow sensors, accelerometers, gyroscopes, inertial sensors, infrared light emitters, cameras including visual and infrared cameras, magnetic sensors, and combinations thereof. In some embodiments, the limb sensor is configured to measure at least one selected from the group consisting of a three-dimensional limb motion velocity, a three-dimensional limb motion acceleration, and one or more limb attitude angles. The measurements obtained by the limb sensor can be referred to as “limb data”, “limb sensor data”, or other similar term. In some embodiments, the limb sensor includes an accelerometer and a gyroscopic sensor. In such an embodiment, the gyroscopic sensor can provide data relating to an orientation of the limb and the accelerometer can provide data relating to the motion of the limb. These two types of data relating to the limb can be combined or integrated to provide an inertial measurement unit. In some embodiments, the inertial measurement unit also includes a magnetometer. The magnetometer can be configured to operate based on the Earth's natural magnetic field or based on a magnetic field from a magnet placed in another component of the system, such as the buoyant kickboard. The magnetometer can provide data relating to an absolute orientation of the limb sensor relative to some external reference source, such as the Earth's natural magnetic field or the buoyant kickboard. Preferably, the inertial measurement unit includes a three-axis accelerometer. The three-axis accelerometer can be formed from three individual one-axis accelerometers arranged so as to provide three orthogonal axes of acceleration measurement. In some embodiments, the limb piece uses the inertial measurement unit to track a limb position relative to a starting limb position. That is, the inertial measurement unit is configured to track changes in the limb position and orientation to provide the measured limb motion.

[0054] In some embodiments, the limb sensor is configured to provide a measurable signal to a limb signal receiver. In some embodiments, the limb signal receiver is disposed on the buoyant kickboard. In such embodiments, the limb signal receiver can detect a limb position or motion relative to the buoyant kickboard. In such embodiment, the limb signal receiver can be included in the projection module described below. In some embodiments, the limb signal receiver is contained within the limb piece. In such embodiments, a first limb sensor associated with a first limb piece can transmit a measurable signal to a second limb receiver associated with a second limb piece.

The second limb sensor associated with the second limb piece can similarly transmit a measurable signal to a first limb receiver associated with the first limb piece. This way, the relative positions and/or motions of the first limb and second limb can be measured. In some embodiments, one or both of the first limb piece and the second limb piece can transmit information related to the first limb and/or second limb to the controller. In some embodiments, the limb piece uses the measurable signal to track a limb position relative to a reference point external to the limb piece. That is, the limb sensor is configured to track the limb position and orientation relative to, for example, the Earth's magnetic field or another component of the system such as the buoyant kickboard, to provide the measured limb motion.

[0055] In some embodiments, the limb sensor is configured to transmit the limb sensor data to the controller. In some embodiments, the limb sensor data is transmitted wirelessly. In such embodiments, the limb sensor can contain or be equipped with a wireless communication module. In such embodiments, the controller can contain, be equipped with, or be connected to a wireless communication module. The inclusion of wireless communication modules with the limb sensor and the controller can permit wireless transmission of data between them.

[0056] In some embodiments, the limb piece is waterproof. That is, the limb piece is capable of being immersed or submerged in water while preventing water from contacting the limb sensor, wireless communication module, or other components or optional components contained within the limb piece. In some embodiments, the limb sensor, wireless communication module, or other components are contained within a waterproof limb sensor case.

[0057] In general, the system can comprise any suitable number of limb pieces. In some embodiments, the system includes only a single limb piece. In some embodiments, the system includes two limb pieces. In such an embodiment, the two limb pieces should include at least one of a wrist piece and an ankle piece. However, the other piece can be any suitable limb piece described above. For example, the two limb pieces can be two wrist pieces, two ankle pieces, a wrist piece and an ankle piece, a wrist piece and an upper arm piece, a wrist piece and an upper leg piece, two ankle pieces, an ankle piece and an upper arm piece, and an ankle piece and an upper leg piece.

[0058] In some embodiments, the limb unit comprises a heartrate sensor.

[0059] In some embodiments, the optical projector is configured to project optical information viewable to the user onto the buoyant kickboard. In some embodiments, the optical information is projected onto a top surface of the buoyant kickboard. Preferably, the optical projector is positioned and/or oriented such that the projected optical information is viewable while the user has the buoyant kickboard in the intended training position. That is, the user can view the projected optical information while using the buoyant kickboard for swimming training.

[0060] In some embodiments, the optical projector is contained within a projector module. In some embodiments, the projector module is disposed on a distal end of the buoyant kickboard. In some embodiments, the projector module is configured to be removably attached to the buoyant kickboard. In some embodiments, the projector module is configured to be secured within the distal end groove as described above. In general, the projector module can be attached to or disposed on the buoyant kickboard in any suitable way or using any suitable attachment mechanism. For example, the projector module can include a clip configured to be secured around the distal end of the buoyant kickboard. Such a clip can position the projection module on the top surface of the buoyant kickboard while the clip extends around an edge of the buoyant kickboard to the bottom surface to securely hold the projector module in place. For example, the projector module can be configured to fit into an opening in the buoyant kickboard.

[0061] Preferably, the projector module is waterproof. That is, the projector module is capable of being immersed or submerged in water while preventing water from contacting the optical projector or other components contained within the projector module. In some embodiments, the projector module comprises a projection window. The projection window can be a transparent or

translucent portion of the projection module. The optical projector can be configured to project the optical information onto the buoyant kickboard through the projection window.
[0062] In some embodiments, the controller is contained within the projector module. That is, the projector module further comprises the controller. In some embodiments, the projector module further comprises a wireless communication module connected to the controller. The wireless communication module can enable or facilitate transmission of electronic information between the controller and some other component of the system, such as a limb sensor, user input device, user input sensor, earpiece, combination of these, or other suitable device or component. In general, the wireless communication module can use any protocol or method for transmitting electronic information, such as Wifi, Bluetooth®, AirPlay®, EDGE, wireless cellular systems such as 3G, 4G and 5G, and the like.
[0063] In some embodiments, the controller is configured to analyze sensor data from limb sensor to detect a limb motion, compare a detected limb motion with a predicted limb motion, generate a user advice, transmit to the optical projector user-readable information including the user advice; and display the user advice using the optical projector. In general, the analysis of the sensor data from the limb sensor can be or include any analysis, modeling, or algorithmic processing known to one of ordinary skill in the art. For example, the analysis can include using the sensor data to determine motions of a pre-programmed model of a limb. The pre-programmed model of a limb can include, for example, specific rigid portions corresponding to rigid portions of the limbs (e.g., upper arm, lower arm, upper leg, lower leg, hand, foot, etc.). The pre-programmed model of a limb can also include articulation points between the rigid potions corresponding to limb joints (e.g., wrist, ankle, knee, elbow, hip, shoulder, etc.). In some embodiments, the limb sensor is a wrist sensor, the detected limb motion is a detected arm motion, the predicted limb motion is a predicted arm motion. In some embodiments, the limb sensor is an ankle sensor, the detected limb motion is a detected leg motion, and the predicted limb motion is a predicted leg motion.
[0064] In general, the user advice can include any suitable optical information viewable by the user. In some embodiments, the user advice is related to specific user motion during swimming. In some embodiments, the user advice is related to correction of the user's limb position and/or limb motion. That is, the user advice can include specific advice intended to instruct the user on better use of their limbs for swimming. In some embodiments, the user advice is related to correction of a user's posture or attitude in the water. In some embodiments, the user advice is related to providing specific motions or exercises for the user to perform. Such specific motions or exercise can be, for example, related to better or more proper use of the user's arms and/or legs, specific training of a certain swimming stroke, better or more proper posture or attitude in the water, breathing, direction control of swimming, warm-up activities, cool-down activities, specific athletic training activities such as a stroke or lap regimen, and the like.
[0065] In general, the optical information of the user advice can take any suitable visual form. For example, the optical information can be in the form of text, icons, pictograms, images, animations, videos, and combinations of these. In some embodiments, the optical information comprises an image or rendering of a human body or portion thereof (e.g., an arm, a leg, the lower body, the upper body, head, etc.). In some embodiments, the optical information comprises a rendering of the detected limb motion. In some embodiments, the optical information comprises a rendering of a preferred limb motion. The preferred limb motion can be one which corresponds to a predicted limb motion and can be intended to provide the user with instruction on how to correct their limb motion to match the preferred limb motion. In some embodiments, the optical information comprises both the rendering of the detected limb motion and a rendering of the preferred limb motion. Such simultaneous display of both the detected and preferred limb motions can be useful in providing corrective motion feedback to the user. In some embodiments, the optical information is devoid of text.
[0066] In some embodiments, the swimming instruction system further comprises an earpiece

configured to be worn on an ear of a user. In come embodiments, the earpiece is configured to receive auditory information from the controller and play the auditory information for the user. Such auditory information can be part of the user advice or can be separate from the user advice. In some embodiments, the auditory information can be or include auditory information related to specific user motions during swimming, as described above. In some embodiments, the auditory information can be or include messages to the user about use of the swimming instruction system. In some embodiments, the auditory information can be or include psychological messages to the user. For example, the psychological messages can be intended to increase a user confidence, decrease a user fear, provide user motivation, or the like. In general, the earpiece can be any suitable earpiece known to one of ordinary skill in the art. Preferably, the earpiece comprises a speaker. In some embodiments, the earpiece comprises a bone conduction speaker. In some embodiments, the earpiece can be a single earpiece configured to be worn in or on both of a user's ears simultaneously. In some embodiments, the earpiece can comprise separate portions, each portion configured to be worn in or on a single ear. In some embodiments, the earpiece is connected to other portions of the swimming instruction system (e.g., the controller) wirelessly. In some embodiments, the earpiece comprises a microphone. In some embodiments, the microphone is a bone conduction microphone.

[0067] In some embodiments, the optical projector comprises a user input sensor configured to receive user input and transmit the user input to the controller. For example, the optical projector can include a camera or other optical sensor. Such an optical sensor can be configured to detect user gestures or the presence of user body parts in certain specific locations. These user gestures or limb placements can be decoded and/or interpreted by the controller to act as user inputs to control the operation of the swimming instruction system. The use of an optical sensor can be combined with projection or display of specific information via the optical projector. For example, the optical projector can provide the user with an image corresponding to a series of icons or a keyboard. User interaction that includes placing a user's hand or finger in the area corresponding to an icon or a key can be captured by an appropriate optical sensor. When captured by the optical sensor, the optical sensor can transmit to the controller a signal corresponding to a user input involving interaction with the icon or key. This way, a user can interact with or control the functions of the controller or swimming instruction system as a whole. For example, a user can provide an input via the user input sensor to acknowledge a prompt provided by the swimming instruction system, initiate a swimming instruction session, end a swimming instruction session, change the parameters of a swimming instruction session, input a user parameter described below, or any combination of these. This may be advantageous for allowing a user to conveniently operate the swimming instruction system while in the water. Particularly, the user may operate the swimming instruction system without an external or additional device, particularly one which is not waterproof, such as a smartphone.

[0068] In some embodiments, the system further comprises a user input device configured to receive user input and transmit the user input to the controller. In general, any suitable device can be used. In some embodiments, the user input device is or is included in a limb piece. For example, the limb piece can be equipped with one or more buttons, touch-sensitive portions, dials, or other suitable interactive structure. User interaction with these interactive structures (e.g., pressing a button) can result in the limb piece transmitting to the controller (e.g., via the wireless communication module), a signal corresponding to the user input. This way, a user can interact with or control the functions of the controller or system as a whole. In some embodiments the user input is a microphone. For example, the earpiece or the optical projector can be equipped with a microphone. The microphone or other component connected to the microphone can be configured to detect a user voice input or voice command. The voice input or voice command can then be transmitted to the controller (e.g., via the wireless communication module).

[0069] In some embodiments, the user input device is a smartphone. For example, the user input

device can be a smartphone running a piece of software or application which is configured to wirelessly communicate with the controller (e.g., via the wireless communication module). Inputs provided to the smartphone, for example via touchscreen, voice command, gesture or motion control, or other input modality can be transmitted to the controller (e.g., via the wireless communication module). This may be advantageous by decreasing the complexity of the swimming instruction system by eliminating the need for dedicated user input structures or interactive structures to be included in the projector module, limb piece, or other component of the swimming instruction system. Such a piece of software or smartphone app can control one or more functions of the controller or swimming instruction system as a whole. Such a piece of software can provide the user a convenient interface for controlling the optical projector or other swimming instruction system component using the smartphone. In some embodiments, the smartphone can be used to provide notifications to the user. In some embodiments, such notifications can be provided even when not connected to the other components of the swimming instruction system. For example, the smartphone app can provide a low battery notification to the user to alert the user that a component of the swimming instruction system (e.g., the projector module or limb piece) has a low battery and is in need of charging. For example, the smartphone app can provide a schedule reminder intended to remind the user of a scheduled swimming instruction session. In some embodiments, a smartphone running a smartphone app can store the information related to the use of the swimming instruction system. Such information related to the use of the swimming instruction system can be stored in a user profile specific to a user. For example, the smartphone app can track a user's instruction history, previous detected limb motions, an advice history, user-defined settings or preferences, a user swimming level, a user competency level, a user physical profile including factors such as sex, height, weight, limb length, etc., and other information related to the user's swimming instruction and/or use of the swimming instruction system. The smartphone app can also interface with or connect to a database comprising any of the instruction history, previous detected limb motions, an advice history, user-defined settings or preferences, a user swimming level, a user competency level, a user physical profile including factors such as sex, height, weight, limb length, etc., other information related to the user's swimming instruction and/or use of the swimming instruction system, swimming instruction regimens or protocols, exercises, information relating to other users or a user community, or any other suitable information.

[0070] In some embodiments, the smartphone and/or smartphone app is the controller. That is, the controller described above can be a physical controller formed by the hardware of the smartphone and/or a virtual controller formed by the smartphone app. In such an embodiment, the functions performed by the controller described above are performed by the smartphone and/or smartphone app. The smartphone and/or smartphone app can, for example, receive the limb sensor data, analyze the limb sensor data to detect a limb motion, compare a detected limb motion with a predicted limb motion, generate a user advice, and transmit to the optical projector user-readable information including the user advice. In some embodiments, the transmission from the smartphone to the optical projector is achieved through the use of the wireless communication module. In such an embodiment, the wireless communication module is physically connected to the optical projector and is configured to wirelessly communicate with the controller and/or other components of the swimming instruction system.

[0071] In some embodiments, the swimming instruction system further comprises a user identification badge disposed on the limb piece. The user identification badge encodes user-identifying information. In some embodiments, the user identification badge is configured to be detected by an identification badge sensor disposed on the optical projector. In some embodiments, the user identification badge is configured to be detected by an optical sensor that is part of the user input device. For example, a smartphone camera can scan the user identification badge. Following detection, the identification badge sensor is configured to decode the user-identifying information.

The user-identifying information can then be transmitted to the controller. In some embodiments, the user-identifying information is associated with a user profile stored within the controller. In some embodiments, the user-identifying information is associated with a user profile stored within the user input device. The user profile can include various information and/or settings used by the controller to configure the swimming instruction system for use by that user. For example, the user profile can include information such as an instruction history, previous detected limb motions, an advice history, user-defined settings or preferences, a user swimming level, a user competency level, a user physical profile including factors such as sex, height, weight, limb length, etc., and other information related to the user's swimming instruction and/or use of the swimming instruction system.

[0072] For example, when a user initiates a session with the swimming instruction system, the user can automatically load the user profile by scanning the user identification badge using the identification badge sensor. Then, the controller can adjust various parameters of the swimming instruction system to provide instruction based on the user profile. The swimming instruction can, for example, tailor the user advice to a specific user and/or can be adjusted based on a user's previous use of the swimming instruction system. For example, the swimming instruction system can load a user physical profile including factors such as sex, height, weight, limb length, etc., and use these factors in detecting the limb motion, comparing the detected limb motion with a predicted limb motion, and/or providing specific advice to the user.

[0073] In some embodiments, the system is configured to provide non-instruction advice to a user. Such non-instruction advice can be or include, for example, advice on specific swimming strokes or techniques, training regimens, motivational messages, lap counts, distances, time spent swimming, time remaining in a specific swim session, and the like. In this way, a user who has learned how to swim can use the system for purposes other than learning to swim. For example, the user can use the system to learn a specific stroke or refine a specific swimming technique or aspect. The system can also be used as a training aid for exercise.

[0074] In some embodiments, the system includes an alarm. In general, the alarm can be configured to produce an alert when the system detects the user is in danger or an unsafe user condition has arisen. For example, if the system detects the user is in distress based on limb motion and/or heartrate, the alarm can be used to automatically request aid or alert persons around the user that the user in need of aid. For example, if the detected limb motion is indicative of frantic, uncontrolled, or otherwise uncoordinated movements not associated with swimming or associated with drowning or distress, the system can trigger the alarm. In some embodiments, the alarm includes a speaker. The speaker can be configured to produce a loud, audible alert to the user and/or other persons around them. In some embodiments, the speaker is included in or disposed on the projection module. In some embodiments, the speaker is included in a separate alarm unit. The alarm unit can be placed nearby and in wireless communication with the controller or other component of the system. For example, the alarm unit can be placed next to a pool or in an associated facility such as a locker room or office while a user is using the system in the pool. In some embodiments, the alarm can include a light. The light can, for example, produce a bright strobing effect when the alarm is activated. In some embodiments, the light is included in or disposed on the projection module. In some embodiments, the light is included in the alarm unit described above. In some embodiments, the alarm includes an electronic notification generator. The electronic notification generator can be any suitable hardware or device configured to produce a notification which can be transmitted to and displayed on a suitable electronic device. For example, the alarm can be configured to provide an alert notification to a user's device or smartphone or to an emergency contact designated by the user. The emergency contact can be included in the user profile described above. In some embodiments, the electronic notification generator is included in the controller. In some embodiments, the notification is provided to a facility administrator, coach, lifeguard, EMT, or other suitable responsible authority. The notification can be received by the

responsible authority on any suitable electronic device, such as a smartphone, tablet, computer, or similar such device capable of receiving a wireless transmission from the system.

[0075] The present disclosure also relates to a method of teaching a user to swim using the swimming teaching system, the method comprising analyzing sensor data from the limb sensor to detect a limb motion, comparing a detected limb motion with a predicted limb motion, generating a user advice, and displaying the user advice using the optical projector. In general, the user advice can include any suitable optical information viewable by the user. In some embodiments, the user advice is related to specific user motion during swimming. In some embodiments, the user advice is related to correction of the user's limb position and/or limb motion. That is, the user advice can include specific advice intended to instruct the user on better use of their limbs for swimming. In some embodiments, the user advice is related to correction of a user's posture or attitude in the water. In some embodiments, the user advice is related to providing specific motions or exercises for the user to perform. Such specific motions or exercise can be, for example, related to better or more proper use of the user's arms and/or legs, specific training of a certain swimming stroke, better or more proper posture or attitude in the water, breathing, direction control of swimming, warm-up activities, cool-down activities, specific athletic training activities such as a stroke or lap regimen, and the like. In some embodiments, the user advice is based on or determined by a user's instruction history, previous detected limb motions, an advice history, user-defined settings or preferences, a user swimming level, a user competency level, a user physical profile including factors such as sex, height, weight, limb length, etc., and other information related to the user's swimming instruction and/or use of the swimming instruction system. For example, the user advice can be tailored to a specific user and/or can be adjusted based on a user's previous use of the swimming instruction system.

[0076] The examples below are intended to further illustrate protocols for the construction and/or operation of the swimming instruction system and/or performance of the method and are not intended to limit the scope of the claims.

[0077] Where a numerical limit or range is stated herein, the endpoints are included. Also, all values and subranges within a numerical limit or range are specifically included as if explicitly written out.

[0078] Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

Examples

[0079] FIGS. **1**A-**1**C show the buoyant kickboard according to an exemplary embodiment of the present disclosure. FIG. **1**A shows the components and features of a buoyant kickboard **101** with a single section. The buoyant kickboard **101** includes a distal end **102** that is convex and a proximal end **103** that is concave. The buoyant kickboard **101** also includes a pair of gripping features **104** that take the form of oblong elliptical cut-outs. A user can place their fingers or palms into the cut-outs to securely hold the buoyant kickboard while in use. The buoyant kickboard **101** also includes a connection point **105** for attaching an additional section (not depicted).

[0080] The exemplary buoyant kickboard depicted in FIG. **1**A also includes a projection module **110** disposed on the distal end **102**. As shown in FIGS. **1**B and **1**C, the projection module **110** is configured to display information to a user by projecting the image onto the buoyant kickboard. FIGS. **1**B and **1**C show exemplary displays of information using the projection module **110**.

[0081] FIGS. **2**A-**2**C show schematic depictions of a projection module **110** according to an exemplary embodiment of the present disclosure. FIG. **2**A shows a side-on view, FIG. **2**B shows a front-on view, and FIG. **2**C shows an end-on view. The depicted projection module **110** includes a clip **111**. The clip is configured to be secured around the distal end of the buoyant kickboard. That is, when the projection module is placed on the distal end, the clip can fit around the distal end such that the clip contacts a bottom surface of the buoyant kickboard while the rest of the projection

module is disposed on the top surface of the buoyant kickboard for projection. The exemplary projection module depicted also includes a projection window **112** through which the information is projected. The exemplary projection module depicted also includes a button **113** which can function as a user input device or part of a user input device. The button **113** can also function as a power switch.

[0082] FIG. **2**D shows a rendering of a projection module **110** according to an exemplary embodiment of the present disclosure. FIG. **2**D shows a three-quarters view. FIG. **2**E shows a blown-out view of the components of the exemplary projection module **110**. The blown-out view shows the projection window **112** and button **113** described above as well as the optical projector **114**, an optical sensor **115**, a controller **116**, and a battery **117**.

[0083] FIGS. **3**A-**3**C show schematic depictions of a limb piece **120** according to an exemplary embodiment of the present disclosure. FIG. **3**A shows a side-on view, FIG. **3**B shows an end-on view, and FIG. **3**C shows a top-down view. The depicted limb piece **120** includes a limb sensor **121** and a strap **122**. The depicted limb piece **120** also includes a user identification badge **123** encoding user-identifying information.

[0084] FIG. **3**D shows a rendering of a limb piece **120** according to an exemplary embodiment of the present disclosure. FIG. **3**D shows a three-quarters view. FIG. **3**E shows a blown-out view of the components of the exemplary limb piece **120**. The blown-out view shows the limb sensor **121**and user identification badge **123** encased in a waterproof housing **124**.

[0085] FIG. **4** shows a depiction of an earpiece according to an exemplary embodiment of the present disclosure.

[0086] FIGS. **5**A-**5**F show images of a user using the system in a method of swimming instruction, according to an exemplary embodiment of the present disclosure. FIG. **5**A depicts the user initiating an instruction session. The user is shown wearing a limb piece on their wrist. The user is scanning the user identification badge using the optical sensor in the projection module. FIG. **5**B depicts the system having decoded the user-identifying information encoded in the user identification badge and displaying a welcome message to the user. The welcome message indicates that the device is ready to begin instruction and lets the user know which user profile is currently active. FIG. **5**C depicts the system projecting onto the buoyant kickboard an image of a person performing a first exercise or activity. In the exemplary image projected onto the buoyant kickboard, a person is shown seated on steps in the water performing kicking motions. FIG. **5**D depicts a user performing the kicking motions depicted in the projected image from FIG. **5**C.

[0087] FIG. **5**E shows the system projecting a detected limb motion. In the detected limb motion being projected, the system can indicate deviations from or comparisons with an ideal or predicted limb motion. For example, the system can compare the detected limb motions and predicted limb motions in factors such as the body posture, limb extension, limb positioning (including starting and/or ending positioning), limb trajectory, limb speed, limb rotation, or combinations of these. In FIG. **5**F, the system is shown projecting a corrected limb motion. This corrected limb motion can be based on the comparison described above. The corrected limb motion can include, for example, specific changes to the detected limb motion that indicate to the user corrections or better motions to make to achieve swimming. For example, in FIG. **5**E, the user's arms are being moved in too high of an arc. FIG. **5**F shows a lower arc that has the user's arm being extended more forward for better, more efficient propulsion in the water.

Claims

1. A swimming instruction system, comprising a buoyant kickboard; an optical projector disposed on the buoyant kickboard configured to project user-readable information onto the buoyant kickboard; a limb piece comprising a limb sensor; and a controller configured to receive sensor data from the limb sensor and transmit user-readable information to the optical projector.

2. The swimming instruction system of claim 1, wherein the buoyant kickboard comprises a polymer which is at least one selected from the group consisting of ethylene-vinyl acetate, polypropylene, polystyrene, polyethylene, polyvinyl chloride, and thermoplastic polyurethane.
3. The swimming instruction system of claim 1, wherein the buoyant kickboard has a substantially flattened shape that includes a distal end that is convex and a proximal end that is concave.
4. The swimming instruction system of claim 3, wherein the buoyant kickboard has a distal end groove disposed in the distal end and oriented substantially parallel to a length of the buoyant kickboard from the distal end to the proximal end.
5. The swimming instruction system of claim 1, wherein the limb piece comprising a limb sensor is at least one selected from the group consisting of a wrist piece comprising a wrist sensor and a wrist strap, and an ankle piece comprising an ankle sensor and an ankle strap.
6. The swimming instruction system of claim 1, wherein the optical projector is contained within a projector module disposed on a distal end of the buoyant kickboard.
7. The swimming instruction system of claim 6, wherein the projector module is configured to be removably attached to the buoyant kickboard.
8. The swimming instruction system of claim 7, wherein the projector module is configured to be secured within a distal end groove disposed in the distal end and oriented substantially parallel to a length of the buoyant kickboard from the distal end to the proximal end.
9. The swimming instruction system of claim 6, wherein the controller is contained within the projector module.
10. The swimming instruction system of claim 9, wherein the projector module further comprises a wireless communication module connected to the controller.
11. The swimming instruction system of claim 10, wherein the system further comprises a user input device configured to receive user input and transmit the user input to the controller.
12. The swimming instruction system of claim 1, wherein the optical projector comprises a user input sensor configured to receive user input and transmit the user input to the controller.
13. The swimming instruction system of claim 1, further comprising a user identification badge disposed on the limb piece and encoding user-identifying information; and an identification badge sensor disposed on the optical projector, wherein the identification badge sensor is configured to detect the user identification badge and decode the user-identifying information.
14. The swimming instruction system of claim 1, further comprising an earpiece configured to be worn on an ear of a user and to receive auditory information from the controller and play the auditory information for the user.
15. The swimming instruction system of claim 1, wherein the controller is configured to analyze sensor data from limb sensor to detect a limb motion; compare a detected limb motion with a predicted limb motion; generate a user advice; transmit to the optical projector user-readable information including the user advice; and display the user advice using the optical projector.
16. The swimming instruction system of claim 15, wherein the limb sensor is a wrist sensor, the detected limb motion is a detected arm motion, the predicted limb motion is a predicted arm motion.
17. The swimming instruction system of claim 15, wherein the limb sensor is an ankle sensor, the detected limb motion is a detected leg motion, and the predicted limb motion is a predicted leg motion.
18. The swimming instruction system of claim 1, wherein the buoyant kickboard comprises a plurality of detachable sections.
19. A method of teaching a user to swim using the swimming teaching system of claim 1, the method comprising analyzing sensor data from the limb sensor to detect a limb motion; comparing a detected limb motion with a predicted limb motion; generating a user advice; and displaying the user advice using the optical projector.
20. The method of claim 19, further comprising producing an auditory advice audible to a user.