

**Title of the Invention: SYSTEM AND METHOD FOR CULTURING AND
TRANSPORTING AQUATIC ANIMALS**

Field of the Invention

5 The invention relates to fish farming and transport technologies, particularly to a modular tank or UniCell, method and system for culturing and transporting aquatic animals, e.g. fish, shrimps and crabs, etc.

Background

10 Currently, the urgency of enhancing food security and self-sufficiency, especially for an import-dependent country, e.g. Singapore, becomes more evident due to more disruptions to global food supply and food prices caused by unpredictable weather events like droughts and floods, and other global crisis like the recent Covid-19 pandemics.

15 Seafood is one of the most common food in our daily lives. It has been reported that the global average consumption of seafood has crept up to 20.5 kilograms per capita. Therefore, to provide steady seafood supply in an import-dependent country like Singapore, it is very important to develop local fish farms and increase productivity thereof. One critical challenge of having more local fish farms is the substantial land occupation and potential pollution to the eco-
20 environment, more so for urbanized cities like Singapore with land scarcity and concern on pollution to the environment. Another challenge for steady seafood

supply is the difficulty in live seafood long-distance transportation to keep the seafood fresh.

It is therefore desirable to provide a solution for reducing the land occupation of fish/seafood farms with eco-friendly features. Also, it is desirable to
5 provide an effective solution to reduce fatality rate of live seafood during long-distance transportation.

Summary of the Invention

Embodiments of the invention provide an environmentally friendly and cost-effective system and method for culturing and transporting aquatic animals.

10 According to a first aspect of the embodiments of the invention, a modular tank for culturing and transporting aquatic animals is provided. The modular tank comprises an inner sidewall and an outer sidewall wherein a closed space is formed between the inner sidewall and the outer sidewall to hold the aquatic animals, wherein the inner sidewall with at least one opening thereon forms a
15 channel to allow an automated aquaculture system to be in fluid communication with the closed space.

According to a second aspect of the embodiments of the invention, a system for culturing and transporting aquatic animals, the system comprising:

a plurality of modular tanks, each tank having an inner sidewall and an
20 outer sidewall wherein a closed space is formed between the inner sidewall and the outer sidewall to hold the aquatic animals, wherein the inner sidewall with at

least one opening thereon of each modular tank forms a channel to allow an automated aquaculture system to be in fluid communication with the closed space, wherein the plurality of modular tanks are arranged in such a manner that the channels of the plurality of modular tanks are substantially aligned with each other
5 to allow the automated aquaculture system to be installed therein.

According to a third aspect of the embodiments of the invention, a method for culturing and transporting aquatic animals, the method comprising:

providing a plurality of modular tanks in a horizontal direction, wherein each tank having an inner sidewall and an outer sidewall to form a closed space
10 between the inner sidewall and the outer sidewall to hold the aquatic animals, wherein the inner sidewall with at least one opening thereon of each tank forms a channel to allow an automated aquaculture system to be in fluid communication with the closed space; arranging the plurality of modular tanks are arranged in such a manner that the channels of the plurality of modular tanks are substantially
15 aligned with each other to allow the automated aquaculture system to be installed therein, and installing the automated aquaculture system in the channel of each tank.

Brief Description of the Drawings

The invention will be described in detail with reference to the accompanying
20 drawings, in which:

[Fig. 1A] is a schematic diagram showing a modular tank for culturing and transporting aquatic animals according to a first embodiment of the invention;

[Fig. 1B] is a cross-sectional view of the modular tank in [Fig. 1A];

[Fig. 1C] is a schematic diagram showing a modular tank for culturing and transporting aquatic animals according to a second embodiment of the invention;

[Fig. 1D] is a cross-sectional view of a modular tank with a non-flat bottom
5 surface according to a first example of the invention;

[Fig. 1E] is a cross-sectional view of a modular tank with two non-flat surfaces according to a second example of the invention;

[Fig. 2] is a schematic diagram illustrating a system for culturing and transporting aquatic animals according to one embodiment of the invention;

10 [Fig. 3A] is a cross-sectional view of an automated monitoring system according to one embodiment of the invention;

[Fig. 3B] is a cross-sectional view of an automated feeding system according to one embodiment of the invention;

[Fig. 3C] is a cross-sectional view of a water treatment system according
15 to one embodiment of the invention;

[Fig. 3D] is a cross-sectional view of an automated extracting system according to one embodiment of the invention;

[Fig. 4A] is a schematic diagram illustrating a first water circulation system used in a system for culturing aquatic animals according to one embodiment of the invention;

[Fig. 4B] is a schematic diagram illustrating a second water circulation system used in a system for culturing aquatic animals according to one embodiment of the invention;

[Fig. 5A] is a schematic diagram illustrating a system used for transporting aquatic animals according to one embodiment of the invention;

[Fig. 5B] shows the system for transporting aquatic animals in [Fig. 5A] which is disposed in a truck;

[Fig. 6] is a flow chart illustrating a method for culturing aquatic animals according to one embodiment of the invention;

[Fig. 7] is a flowchart illustrating a method for transporting aquatic animals according to one embodiment of the invention.

15 **Detailed Description of Embodiments of the Invention**

In the following description, numerous specific details are set forth in order to provide a thorough understanding of various illustrative embodiments of the invention. It will be understood, however, to one skilled in the art, that embodiments of the invention may be practiced without some or all of these specific details. It is understood that the terminology used herein is for the purpose

of describing particular embodiments only and is not intended to limit the scope of the invention.

Embodiments described in the context of one of the systems or methods are analogously valid for the other systems or methods. Similarly, embodiments
5 described in the context of a method are analogously valid for a system, and vice versa.

Features that are described in the context of an embodiment may correspondingly be applicable to the same or similar features in the other embodiments. Features that are described in the context of an embodiment may
10 correspondingly be applicable to the other embodiments, even if not explicitly described in these other embodiments. Furthermore, additions and/or combinations and/or alternatives as described for a feature in the context of an embodiment may correspondingly be applicable to the same or similar feature in the other embodiments.

15 As used herein, the articles “a”, “an” and “the” as used with regard to a feature or element include a reference to one or more of the features or elements.

As used herein, the term “configured to” is interchangeable with “operative to” or “adapted to”.

As used herein, the term “coupled to” refers to connecting to an element
20 with or without a coupling means.

[Fig. 1A] is a schematic diagram showing a modular tank 10 for culturing and transporting aquatic animals according to a first embodiment of the invention. Referring to [Fig. 1A], the modular tank 10 has an outer sidewall 101 and an inner sidewall 102, wherein a closed space 103 is formed between the outer sidewall 101 and the inner sidewall 102 to hold the aquatic animals, wherein the inner sidewall 102 with at least one opening thereon forms a channel 104 to allow an automated aquaculture system to be in fluid communication with the closed space 103.

[Fig. 1B] is a cross-sectional view of the modular tank 10. Referring to [Fig. 1B], in this embodiment, there are two openings on the inner sidewall 102 of each modular tank 10. It should be noted that in other embodiments of the invention, there may be more than two openings on the inner sidewall 102 of each modular tank 10. The number of the openings may be determined according to actual need, e.g. depending on the functions and operations of the automated aquaculture system to be installed in the channels of the modular tanks 10.

In the embodiment shown in [Fig. 1A], both the outer sidewall 101 and the inner sidewall 102 are in a cylinder shape. The inner sidewall 102 forms a cylinder-shaped channel 104. It should be noted that in other embodiments, the shape of the outer sidewall 101 and the inner sidewall 102 may be different. For example, [Fig. 1C] is a schematic diagram showing a modular tank 10 for culturing and transporting aquatic animals according to a second embodiment of the invention. As shown in [Fig. 1C], the inner sidewall 102 of the modular tank 10 forms a cube-shaped channel 104.

In some embodiments of the invention, the modular tank 10 may include a non-flat bottom surface, e.g. a curved surface, an inclined surface, or a surface with a bulge structure, to form a lower area on the bottom of the modular tank 10 so that impurities in the modular tank 10, e.g. food residues and excrement of aquatic animals such as fish, can settle and gather in the lower area. [Fig. 1D] is a cross-sectional view of a modular tank with a non-flat bottom surface according to a first example of the invention. In this example, the non-flat bottom surface is an inclined surface to form a lower area near the inner side wall 102 of the modular tank 10. [Fig. 1E] is a cross-sectional view of a modular tank 10 with two non-flat surfaces according to a second example of the invention. When the modular tank 10 is used, both non-flat surfaces can be the bottom surface of the modular tank 10.

In some embodiments of the invention, the modular tank 10 may further include a top coupling structure and/or a bottom coupling structure and/or a side coupling structure, wherein the top coupling structure and the bottom coupling structure are configured to removably attached the modular tank 10 to another modular tank 10; wherein the side coupling structure is configured to removably couple the modular tanks 10 to a frame, e.g. a vertical frame or a horizontal frame.

In some embodiments of the invention, the modular tank 10 may be made of strong and light material such as fibre glass, or strong, light and transparent material, e.g. transparent acrylics or tempered glass.

Embodiments of the invention have also provided a system for culturing and transporting aquatic animals. The system includes a plurality of modular tanks, each modular tank having an inner sidewall and an outer sidewall, wherein a closed space is formed between the inner sidewall and the outer sidewall to hold the aquatic animals, and the inner sidewall with at least one opening thereon of each modular tank forms a channel to allow an automated aquaculture system to be in fluid communication with the closed space, wherein the plurality of modular tanks are arranged in such a manner that the channels of the plurality of modular tanks are substantially aligned with each other to allow the automated aquaculture system to be installed therein.

In some embodiments of the invention, the automated aquaculture system may include at least one of the following systems:

- (1) an automatic monitoring system configured to detect water quality and/or status of the aquatic animals in the closed space of each modular tank, wherein the status of the aquatic animals includes size, quantity and health index of the aquatic animals,
- (2) an automated feeding system configured to automatically transfer food to any one of the plurality of modular tanks according to a predetermined feeding schedule, and/or status of the aquatic animals in each modular tank
- (3) a water treatment system configured to conduct water treatment process to improve quality of the water in each modular tank when needed;

(4) an automated extracting system configured to extract the aquatic animals in any one of the plurality of modular tanks automatically according to a predetermined time schedule or status of the aquatic animals in the closed space of each modular tank, and

5 (5) a water circulation system configured to improve the water quality in each modular tank by discharging water in any modular tank back to an external water source, e.g. the sea, and bringing clean water from the external water source, e.g. seawater at a predetermined depth, to any modular tank in the system. It should be noted that the water circulation system is only provided
10 when the system is used for culturing aquatic animals. In addition, to avoid potential pollution to the water space, before discharging the water from the modular tank to the external water source, a water treatment process may be conducted to clean the water if the water quality does not satisfy a predetermined criterion.

15 In some embodiments of the invention, each modular tank may include a top coupling structure and/or a bottom coupling structure which are configured to removably couple the modular tank to another modular tank so that the plurality of modular tanks are arranged in such a manner that the channels of the plurality of modular tanks are substantially aligned with each other. Alternatively, in some
20 embodiments of the invention, the plurality of modular tanks may be installed in a frame so that the plurality of modular tanks are arranged in such a manner that the channels of the plurality of modular tanks are substantially aligned with each other. Each modular tank may include a side coupling structure configured to

removably couple the modular tank to the frame. The frame may be a vertical frame when the modular tank is used for culturing aquatic animals in some embodiments of the invention; or a horizontal frame when the modular tank is used for transporting aquatic animals in some embodiments of the invention.

5 In some embodiments of the invention, when the system is used for culturing aquatic animals, to reduce land occupation of the system, the plurality of modular tanks are arranged in a vertical direction in such a manner that the channels of the plurality of modular tanks are substantially aligned with each other in the vertical direction. To further reduce land occupation of the system when it
10 is used for culturing aquatic animals, the system may be disposed in an underground shaft.

 In some embodiments of the invention, when the system is used for transporting aquatic animals, the plurality of modular tanks may be arranged in a horizontal direction in such a manner that the channels of the plurality of modular
15 tanks are substantially aligned with each other in the horizontal direction. This arrangement is more suitable for disposing the system in a transportation vehicle for long-distance transportation, e.g. trucks and trains, etc.

 In some embodiments of the invention, when the modular tank 10 is used for culturing and transporting aquatic animals, preferably, the outer sidewall 101
20 is in a cylinder shape to alleviate or minimize the impact force generated during the transportation of the aquatic animals, and to provide a closed space with a maximum volume. Further, when the system is disposed in an underground shaft

to culture aquatic animals, as the underground shaft is typically in a cylinder shape, the modular tank with a cylinder-shaped outer sidewall will maximize the space occupancy of the shaft.

[Fig. 2] is a schematic diagram illustrating a system 100 for culturing and transporting aquatic animals according to one embodiment of the invention. As shown in [Fig. 2], in this embodiment, the system 100 includes four modular tanks 10 which are arranged in a vertical direction in such a manner that the channels of the plurality of modular tanks are substantially aligned with each other in the vertical direction. The system 100 may be used for culturing aquatic animals as the vertical arrangement of the plurality of modular tanks 10 can significantly reduce land occupation of the culturing system. To minimize land occupation of the culturing system, the system 100 may be disposed in an underground shaft.

In this embodiment, each modular tank 10 includes a top coupling structure and a bottom coupling structure so that each modular tank 10 is removably coupled to another one. It should be noted that in other embodiments of the invention, the four modular tanks 10 may be installed in a vertical frame, each connected to another or not, so that the channels of the plurality of modular tanks 10 are aligned with each other in the vertical direction.

In this embodiment, the automated aquaculture system 20 which is installed in the channels of the modular tanks 10 includes an automated aquaculture apparatus 20a and a plurality of pipelines 20b for conducting various automated aquaculture processes.

In this embodiment, the automated aquaculture system 20 may include an automatic monitoring system, an automated feeding system, a water treatment system, an automated extracting system, and/or a water circulation system.

[Fig. 3A] is a cross-sectional view of the automated monitoring system according to one embodiment of the invention. Referring to [Fig. 3A], the automatic monitoring system may include at least one camera 201a installed on the inner sidewall 102 and/or in the channel 104 of each modular tank 10. The at least one camera 201a is configured to detect water quality and/or status of the aquatic animals in the closed space of each modular tank 10, the status of the aquatic animals includes size, quantity and health index of the aquatic animals.

[Fig. 3B] is a cross-sectional view of the automated feeding system according to one embodiment of the invention. Referring to [Fig. 3B], the automated feeding system may include a first pipeline 201b which is installed in the channel of each modular tank 10 and fluidly communicable with the closed space of each modular tank 10 through a first opening 105a on the inner sidewall 102 of each modular tank 10, wherein the feeding system is configured to automatically transfer food to any one of the plurality of modular tanks 10 through the first pipeline 201b according to a predetermined feeding schedule, and/or status of the aquatic animals in each modular tank 10. The status of the aquatic animals may be detected by the automatic monitoring system 201 and may include size, quantity and health index of the aquatic animals.

Referring to [Fig. 3C], the water treatment system may include a second pipeline 202b and a third pipeline 203b which are fluidly communicable with the closed space of each modular tank 10 through a second opening 105b and a third opening 105c on the inner sidewall 102 of each modular tank 10 respectively.

5 The water treatment system is configured to bring, by using a pump, water in any modular tank 10 to a water treatment apparatus in the automated aquaculture apparatus 20a through the second pipeline 202b so that a water treatment process is conducted to improve water quality of the water from the modular tank 10; and transfer the water after treatment back to the modular tank 10 through the third
10 pipeline 203b. The water treatment process conducted by the water treatment apparatus may include physical processes such as settling and filtration, chemical processes such as disinfection and coagulation, and biological processes such as slow sand filtration. The water treatment system may be configured to be activated according to a predetermined time schedule, or water quality in each modular tank
15 10. The water quality in each modular tank 10 may be detected by the automatic monitoring system. The automatic monitoring system may further include two sets of sensors, one set is installed inside the second pipeline 202b; the other set is installed inside the second pipeline 203b.

[Fig. 3D] is a cross-sectional view of the automated extracting system
20 according to one embodiment of the invention. Referring to [Fig. 3D], the automated extracting system may include a fourth pipeline 204b which is fluidly communicable with the closed space of each modular tank 10 through a fourth opening 105d on the inner sidewall 102 of each modular tank 10. The automated

extracting system is configured to extract the aquatic animals in any one of the plurality of modular tanks 10 automatically according to a predetermined time schedule or status of the aquatic animals in the closed space of each modular tank 10. To avoid hurt the aquatic animals when extracting the aquatic animals from the modular tanks 10, the fourth pipeline 204b is preferably a flexible and soft pipeline. Further, the automated extracting system may further include a fish net 204c installed in each modular tank 10 configured to be activated to force the aquatic animals in the modular tank 10 to leave from the modular tank 10 through the opening 105d.

10 It should be noted that in some embodiments, the automated feeding system and the automated extracting system may share common pipeline and openings on the channels of the modular tanks 10.

The automated aquaculture system 20 may further include a water circulation system. The water circulation system includes a fifth pipeline which is fluidly communicable with the closed space of each modular tank 10 through a fifth opening and a sixth opening on the inner sidewall 102 of each modular tank 10 respectively.

The water circulation system is configured to discharge water in any one of the plurality of modular tanks 10, and bring clean water from an external water source to any of the modular tanks 10 through the fifth pipeline, to ensure water quality in the modular tanks 10 satisfies a predetermined criteria. The water circulation system may be activated according to a predetermined time schedule,

and/or water quality in each modular tank 10. The water quality in each modular tank 10 may be detected by the automatic monitoring system. The automatic monitoring system may further include two sets of sensors, one set is installed inside an inlet portion of the fifth pipeline, and the other set is installed inside an outlet portion of fifth pipeline. The water circulation system may further include a water treatment apparatus which is configured to conduct a water treatment process to improve the water quality of the water discharged from the modular tanks 10 to avoid potential environmental pollution. The water treatment apparatus may be activated when the detection results of the automatic monitoring system show that the water quality of the water discharged from the modular tank 10 does not satisfy a predetermined criterion.

[Fig .4A] is a schematic diagram illustrating a first water circulation system used in a system 200 for culturing aquatic animals according to one embodiment of the invention. In this embodiment, the system 200 including 13 modular tanks 10 is disposed in an underground shaft 210, and the external water source is the sea.

As shown in [Fig. 4A], the bottom/lower part of the system 200 may be disposed in an underwater cavern 205A. The fifth pipeline 205b includes a seawater intake portion 205b-1 having an inlet 205B which is disposed at a predetermined depth below a sea level, e.g. a position below the sea level with a 10m waterhead, and a seawater discharging portion 205b-2 having an outlet 205C which is disposed on or close to a sea surface. The underwater cavern 205A may have a substantially same waterhead with the position of the inlet 205B, e.g. 10m

waterhead. The seawater intake portion 205b-1 forms a substantial inverted U-shape siphonic structure to allow seawater at the predetermined depth to enter into the seawater intake portion, wherein the seawater intake portion 205b-1 is fluidly communicable with the closed space of each modular tank 10 through the fifth opening (not shown in Figures) on the inner sidewall 102 of each modular tank 10.

The seawater discharging portion 205b-2 and a part of the seawater intake portion 205b-1 forms a substantial U-shape siphonic structure to bring the seawater close to the sea surface, wherein the seawater discharging portion 205b-2 is fluidly communicable with the closed space of each modular tank 10 through the sixth opening (not shown in Figures) on the inner sidewall 102 of each modular tank 10.

During the circulation of the seawater in the water circulation system, the Gravitational Potential Energy may be partially lost due to the friction within the fifth pipeline 205b. Therefore, a pump 210 may be provided to offset the loss of Gravitational Potential Energy so that the water from each modular tank 10 can be discharged back to the sea when needed.

[Fig .4B] is a schematic diagram illustrating a second water circulation system used in a system 300 for culturing aquatic animals according to one embodiment of the invention. In this embodiment, the aboveground system 300 includes four subsystems 300a, and each subsystem 300a is formed by arranging three modular tanks 10 in a vertical direction. The external water source is the sea.

Referring to [Fig.4B], the water circulation system includes a fifth pipeline 205b which is fluidly communicable with the closed space of each modular tank 10 through a fifth opening and a sixth opening (not show in Figures) on the inner sidewall of each modular tank 10 respectively.

5 The water circulation system is configured to discharge water in any one of the plurality of modular tanks 10 back to the sea, and bring seawater at a predetermined depth to any of the modular tanks 10 through the fifth pipeline 205b, to ensure water quality in the modular tanks 10 satisfies a predetermined criteria. The water circulation system may be activated according to a predetermined time
10 schedule, and/or water quality in each modular tank 10. The water quality in each modular tank 10 may be detected by the automatic monitoring system. The automatic monitoring system may further include two sets of sensors, one set is installed inside an inlet portion of the fifth pipeline 205b, and the other set is installed inside an outlet portion of fifth pipeline 205b. A pump may be used to
15 bring seawater to each of the modular tanks 10. Further, the water circulation system may further include a water treatment apparatus configured to conduct a water treatment process to improve the water quality of the water from the modular tank 10 to avoid potential environmental pollution. The water treatment apparatus may be activated when the detection results of the automatic monitoring system
20 show that the water quality of the water discharged from the modular tank 10 does not satisfy a predetermined criterion.

[Fig. 5A] is a schematic diagram illustrating a system 500 used for transporting aquatic animals according to one embodiment of the invention. [Fig.

5B] shows the system for transporting aquatic animals in [Fig. 5A] which is disposed in a truck. Referring to [Fig. 5A], the system 500 includes four modular tanks 10, each modular tank 10 having an inner sidewall and an outer sidewall to form a closed space between the inner sidewall and the outer sidewall to hold the aquatic animals, wherein the inner sidewall with at least one opening thereon of each tank forms a channel to allow an automated aquaculture system to be in fluid communication with the closed space, wherein the four modular tanks 10 are arranged in a horizontal direction in such a manner that the channels of the modular tanks 10 are substantially aligned with each other in the horizontal direction.

When the system 500 is used for transporting aquatic animals, the automated aquaculture system 20 may include an automatic monitoring system, an automated feeding system, a water treatment system, and/or an automated extracting system, as shown in [Fig.3A] to [Fig. 3D].

Embodiments of the invention also provide a method for culturing aquatic animals. The method comprises: providing a plurality of modular tanks, wherein each modular tank having an inner sidewall and an outer sidewall to form a closed space between the inner sidewall and the outer sidewall to hold the aquatic animals, wherein the inner sidewall with at least one opening thereon of each modular tank forms a channel to allow an automated aquaculture system to be in fluid communication with the closed space; arranging the plurality of modular tanks in such a manner that the channels of the plurality of modular tanks are substantially aligned with each other to allow the automated aquaculture system

to be installed therein, and installing the automated aquaculture system in the channel of each modular tank.

[Fig. 6] is a flowchart showing a method for culturing aquatic animals according to one embodiment of the invention.

5 **Block 601**, a plurality of modular tanks are provided. Each modular tank having an inner sidewall and an outer sidewall to form a closed space between the inner sidewall and the outer sidewall to hold the aquatic animals, wherein the inner sidewall with at least one opening thereon of each tank forms a channel to allow an automated aquaculture system to be in fluid communication with the
10 closed space, wherein the plurality of modular tanks are arranged in such a manner that the channels of the plurality of modular tanks are aligned with each other in the vertical direction.

Block 602, the plurality of modular tanks are arranged in a vertical direction.

Block 603, the automated aquaculture system is installed in the channel of
15 each modular tank.

[Fig. 7] is a flowchart showing a method for transporting aquatic animals according to one embodiment of the invention.

Block 701, a plurality of modular tanks are provided. Each modular tank having an inner sidewall and an outer sidewall to form a closed space between
20 the inner sidewall and the outer sidewall to hold the aquatic animals, wherein the inner sidewall with at least one opening thereon of each tank forms a channel to

allow an automated aquaculture system to be in fluid communication with the closed space, wherein the plurality of modular tanks are arranged in such a manner that the channels of the plurality of modular tanks are aligned with each other in the vertical direction.

5 **Block** 702, the plurality of modular tanks are arranged in a horizontal direction.

Block 703, the automated aquaculture system is installed in the channel of each modular tank.

As will be appreciated from the above, embodiments of the invention
10 provide a modular tank for culturing and transporting aquatic animals, e.g. Fish. With this modular tank, a system for culturing aquatic animals, e.g. a fish farm, with reduced land occupation can be easily formed by arranging a plurality of the modular tanks in a vertical direction. To further reduce land occupation of the culturing system, the vertical arrangement of the modular tanks may be disposed
15 in an underground shaft. In addition, each modular tank in the system may be used to culture different types of seafood.

Further, as each modular tank has a channel to allow an automated aquaculture system to be installed therein. With the automated aquaculture system, the productivity of the seafood in the system may be significantly
20 increased since the status of the aquatic animals in the system may be detected by an automated monitoring system, the feeding may be controlled by an automated feeding system based on a predetermined schedule or the status of

the aquatic animals in each modular tank, and the water quality in the system may be detected and improved when needed by a water treatment system and/or a water circulation system.

Additionally, the system for culturing and transporting aquatic animals
5 proposed in embodiments of the invention is a closed-containment system or a system with a natural circulation in water space, the potential environmental pollution will be reduced/avoided. Especially, when the water circulation system is provided to improve the water quality in each modular tank, the water in the modular tank may be discharged back into the sea and the seawater with better
10 quality at a predetermined depth is brought to the modular tank for culturing the aquatic animals. With this cost-effective and energy efficient system, a natural circulation system is formed to minimize potential environmental pollution to the water space.

Also, when the modular tanks are arranged in a horizontal direction, a
15 system suitable for transporting aquatic animals may be provided. As the automated aquaculture system may be installed in the channel of each modular tank, the fatality rate of live seafood during long-distance transportation can be greatly reduced when the system proposed in embodiments of the invention is used.

20 It is to be understood that the embodiments and features described above should be considered exemplary and not restrictive. Many other embodiments will be apparent to those skilled in the art from consideration of the specification and

practice of the invention. The scope of the invention should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. Furthermore, certain terminology has been used for the purposes of descriptive clarity, and not to limit the disclosed

5 embodiments of the invention.

Claims

[Claim 1] A modular tank for culturing and transporting aquatic animals, the modular tank comprising:

an inner sidewall and an outer sidewall, wherein a closed space is
5 formed between the inner sidewall and the outer sidewall to hold the aquatic animals, and the inner sidewall with at least one opening thereon forms a channel to allow an automated aquaculture system to be in fluid communication with the closed space.

[Claim 2] The modular tank according to claim 1, wherein the outer sidewall of the
10 modular tank is in a cylinder shape.

[Claim 3] The modular tank according to claim 1 or claim 2, further comprising a top coupling structure, a bottom coupling structure, and/or a side coupling structure, wherein the top coupling structure and the bottom coupling structure are configured to removably attached the modular tank to another modular tank;
15 wherein the side coupling structure is configured to removably couple the modular tank to a frame.

[Claim 4] The modular tank according to any preceding claim, wherein the modular tank includes a non-flat bottom surface to form a lower area on the bottom of the modular tank.

20 [Claim 5] A system for culturing and transporting aquatic animals, the system comprising:

a plurality of modular tanks, each modular tank having an inner sidewall and an outer sidewall, wherein a closed space is formed between the inner sidewall and the outer sidewall to hold the aquatic animals, and the inner sidewall with at least one opening thereon forms a channel to allow an automated
5 aquaculture system to be in fluid communication with the closed space, and

wherein the plurality of modular tanks are arranged in such a manner that the channels of the plurality of modular tanks are substantially aligned with each other to allow the automated aquaculture system to be installed therein.

[Claim 6] The system according to claim 5, wherein the plurality of modular tanks
10 are arranged in a horizontal direction when the system is used for transporting aquatic animals.

[Claim 7] The system according to claim 5, wherein the plurality of modular tanks are arranged in a vertical direction when the system is used for culturing aquatic animals.

15 [Claim 8] The system according to any one of claim 5 to claim 7, wherein the outer sidewall of each modular tank is in a cylinder shape.

[Claim 9] The system according to any one of claim 5 to claim 8, wherein each of the plurality of modular tanks includes a top coupling structure, a bottom coupling structure, and/or a side coupling structure, wherein the top coupling structure and
20 the bottom coupling structure are configured to removably attached the modular

tank to another modular tank; wherein the side coupling structure is configured to removably couple the modular tank to a frame.

[Claim 10] The system according to any one of claim 5 to claim 9, wherein the automated aquaculture system further includes a first automatic monitoring system, wherein the automatic monitoring system includes at least one camera which is configured to detect water quality and/or status of the aquatic animals in the closed space of each modular tank, the status of the aquatic animals includes size, quantity and health index of the aquatic animals, wherein the at least one camera is installed on the inner sidewall and/or in the channel of each modular tank.

[Claim 11] The system according to any one of claim 5 to claim 10, wherein automated aquaculture system further includes an automated feeding system, wherein the automated feeding system includes a first pipeline which is installed in the channel of each modular tank and fluidly communicable with the closed space of each modular tank through a first opening 105a on the inner sidewall of each modular tank, wherein the automated feeding system is configured to automatically transfer food to any one of the plurality of tanks through the first pipeline according to a predetermined feeding schedule, and/or status of the aquatic animals in each modular tank, wherein the status of the aquatic animals includes size, quantity and health index of the aquatic animals.

[Claim 12] The system according to any one of claim 5 to claim 11, wherein the automated aquaculture system further includes a water treatment system, wherein

the water treatment system includes a second pipeline and a third pipeline which are fluidly communicable with the closed space of each modular tank through a second opening and a third opening on the inner sidewall of each modular tank respectively,

5 wherein the water treatment system is configured to bring water in any of the plurality of modular tanks to a water treatment apparatus through the second pipeline so that a water treatment process is conducted to improve water quality of the water from the modular tank; and transfer the water after treatment back to the modular tank through the third pipeline, wherein the water treatment system is
10 configured to be activated to improve water quality in any one of the plurality of the tanks according to a predetermined time schedule, or water quality in each tank.

[Claim 13] The system according to claim 12, further comprising a second automated monitoring system which includes two sets of sensors, one set of the
15 sensors is installed in the second pipeline, and the other set of the sensors is installed in the third pipeline.

[Claim 14] The system according to any one of claim 5 to claim 13, wherein the automated aquaculture system further includes an automated extracting system, wherein the extracting system includes a fourth pipeline which is fluidly
20 communicable with the closed space of each modular tank through a fourth opening on the inner sidewall of each modular tank, wherein the extracting system is configured to extract the aquatic animals in any one of the plurality of modular

tanks automatically by activating a fish net installed in the modular tank to force the aquatic animals therein to leave from the modular tank through the fourth opening, according to a predetermined time schedule or status of the aquatic animals in the closed space of each modular tank.

5 [Claim 15] The system according to any one of claim 7 to claim 14, wherein the automated aquaculture system further includes a water circulation system, wherein the water circulation system includes a fifth pipeline which is fluidly communicable with the closed space of each modular tank through a fifth opening and a sixth opening on the inner sidewall of each modular tank respectively,

10 wherein the water circulation system is configured to discharge water in any one of the plurality of modular tanks, and bring clean water from an external water source to any of the modular tanks through the fifth pipeline, to ensure water quality in each modular tank satisfies a predetermined criteria, wherein the water circulation system is activated according to a predetermined time schedule, and/or
15 water quality in each modular tank.

[Claim 16] The system according to claim 15, further comprising a third automated monitoring system which includes two sets of sensors, one set of the sensors is installed in the fifth pipeline, and the other set of the sensors is installed in the sixth pipeline.

20 [Claim 17] The system according to claim 15 or claim 16, wherein the water circulation system is configured to discharge water in any one of the plurality of

modular tanks back to sea, and bring seawater at a predetermined depth to any of the modular tanks through the fifth pipeline by using a pump.

[Claim 18] The system according to claim 15 or claim 16, wherein the plurality of modular tanks are disposed in an underground shaft.

5 [Claim 19] The system according to claim 18, wherein the fifth pipeline of the water circulation system includes a seawater intake portion having an inlet which is disposed at a predetermined depth below a sea level, and a seawater discharging portion having an outlet which is disposed on or close to a sea surface,

wherein the seawater intake portion forms a substantial inverted U-shape
10 siphonic structure to allow seawater at the predetermined depth to enter into the seawater intake portion, wherein the seawater intake portion is fluidly communicable with the closed space of each tank through a first opening on the inner sidewall of each modular tank;

wherein the seawater discharging portion and a part of the seawater intake
15 portion forms a substantial U-shape siphonic structure to bring the seawater close to the sea surface, wherein the seawater discharging portion is fluidly communicable with the closed space of each tank through a second opening on the inner sidewall of each modular tank.

[Claim 20] A method for culturing and transporting aquatic animals, comprising:

20 providing a plurality of modular tanks, wherein each modular tank having an inner sidewall and an outer sidewall, wherein a closed space is formed between

the inner sidewall and the outer sidewall to hold the aquatic animals, and the inner sidewall with at least one opening thereon of each modular tank forms a channel to allow an automated aquaculture system to be in fluid communication with the closed space,

- 5 arranging the plurality of modular tanks in such a manner that the channels of the plurality of modular tanks are substantially aligned with each other to allow the automated aquaculture system to be installed therein, and

 installing the automated aquaculture system in the channel of each modular tank.

- 10 [Claim 21] The method according to claim 20, wherein the step of arranging the plurality of modular tanks comprises arranging the plurality of modular tanks in a vertical direction when the modular tanks are used for culturing aquatic animals; or arranging the plurality of modular tanks in a horizontal direction when the modular tanks are used for transporting aquatic animals.

15