

**AN AUTOMATED MATERIAL DISPENSING SYSTEM FOR DISPENSING
MATERIAL TO MARINE LIFE**

Technical Field

5 The present invention relates to an automated material dispensing system for dispensing material, such as food, to marine life. The invention also relates to a method of automatically dispensing material to marine life.

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Background

One of the problems faced while rearing fish is the arduous task of feeding the fish with the appropriate
15 amount of food at scheduled times. This problem is particularly evident when raising young, first feeding fishes and certain more vulnerable fish species.

Medaka and Zebra fish are commonly used as animal models in medical research but these fish are somewhat
20 sensitive to overfeeding and underfeeding, which can inhibit their ability to be used as animal models in research. Hence, in research institutions where marine life, such as Zebra fish, are used for experimental purposes, the experimental conditions including feeding
25 quantity and time should be consistent in order to achieve reliable and reproducible experimental results.

Nuances including the quantity, quality and timing of feeding have to be constantly monitored at numerous
30 time intervals during the day, to ensure the fish survivability. If the fish are not constantly fed small amounts at regular intervals, there can be a significant

loss of fish or loss of reproductivity due to starvation. Of the fishes that do survive, there may be an uneven size distribution since the fishes have not been trained to feed properly and most would have had their growth restricted due to the sub-optimal level of feeding.

Furthermore, in medical research, it is often necessary to dispense other materials to the fish, such as candidate medicines. It is important that in such situations that the candidate medicines are dispensed according to a strict administration regime to ensure accurate and reproducible results.

A problem with manual dispensing of material to marine life is that a large amount of manpower and time is typically required to dispense the material to the fish. Not only can this be inaccurate but it is also generally inconvenient. For example, Zebra fish may have to be fed with accurate amounts of fish food several times per day. Hence, current laboratory practice requires that an operator be available to feed the Zebra fish according to their strict feeding regime. Not only can this be inconvenient, particularly during holiday periods, but it may also be more costly if the operator must be paid.

It will be appreciated that the above-mentioned problems are further exacerbated when there are numerous aquariums that require such attention, as is common in laboratories that utilize marine life for research.

In view of the above, several attempts have been made to address the problem of the manually intensive feeding schedules. One known automatic fish feeder comprises a dispensing unit located adjacent to a fish

tank. The dispensing unit comprises a container containing the fish feed that is supported by a saddle. Gears cause the saddle to rotate until the dispensing end of a canister strikes a shaft on the canister. The jarring action of this striking action is sufficient to cause the fish feed to be dispensed from the container. However a single container can not be employed to service numerous aquatic tanks as is common in marine life research laboratories and a dispensing unit is required to service each of the containers. Furthermore, the striking action required to actually dispense the fish feed to the fish tank is not accurate and hence, the actual amount of feed dispensed to the fish tank may be somewhat arbitrary.

Another fish feed dispensing system employs a vibratory feeding device, which utilizes an electromagnet connected to an AC power supply to generate a vibratory motion to dispense feed. Again, this dispenser is not accurate and the system requires a dedicated vibratory feeding device to service each of the fish tanks. Hence, the system is not suitable for multiple fish tanks.

In view of the above, there is a need to provide an automated dispensing system for dispensing material to marine animals, that overcomes, or at least ameliorates, one or more of the disadvantages described above.

Summary

According to a first aspect, there is provided an automated material dispensing system for dispensing material to marine life, the system comprising:

a plurality of containers capable of supporting marine life therein, each container and having a material intake portion for receiving material therein to be dispensed to said marine life;

a material receptacle capable of containing said material therein to be dispensed to said marine life;

a transport means for transporting said material receptacle to said material intake portions of each of said plurality of containers during a dispensing operation; and

a control means for controlling movement of said material receptacle along said transport means and dispensation of said material to each of said plurality of containers during said dispensing operation according to predetermined instructions, wherein said dispensation of said material is actuated by a pressure differential being applied within said material receptacle.

According to a second aspect, there is provided an automated method of dispensing material to marine life comprising:

- a) providing a plurality of containers capable of supporting marine life therein, each of said containers having a material intake portion for receiving material therein to be dispensed to said marine life;
- b) moving, under direction of a controller according to predetermined instructions, a receptacle containing said material to be dispensed to said material intake portions of each of said containers; and
- c) dispensing, under direction of said controller according to said predetermined instructions,

said material while said receptacle is located at each of said material intake portions, wherein said dispensation of said material is actuated by a pressure differential being applied within said material receptacle.

According to a third aspect there is provided, an automated material dispensing system for dispensing material to a plurality of containers capable of supporting marine life therein, each container and having a material intake portion for receiving material therein to be dispensed to said marine life, the system comprising:

- a material receptacle capable of containing said material therein to be dispensed to said marine life;

- a transport means for transporting said material receptacle to said material intake portions of each of said plurality of containers during a dispensing operation; and

- a control means for controlling movement of said material receptacle along said transport means and dispensation of said material to each of said plurality of containers during said dispensing operation according to predetermined instructions, wherein the dispensation of said material is activated by a pressure differential being applied within said material receptacle.

Definitions

The following words and terms used herein shall have the meaning indicated:

The term "marine life" refers to any living organism capable of living in an aquatic environment, including complex marine multi-cellular organisms such as fish and plankton, and single cell marine organisms and Bacterioplankton.

Unless specified otherwise, the terms "comprising" and "comprise", and grammatical variants thereof, are intended to represent "open" or "inclusive" language such that they include recited elements but also permit inclusion of additional, unrecited elements.

As used herein, the term "about", in the context of concentrations of components of the formulations, typically means $\pm 5\%$ of the stated value, more typically $\pm 4\%$ of the stated value, more typically $\pm 3\%$ of the stated value, more typically, $\pm 2\%$ of the stated value, even more typically $\pm 1\%$ of the stated value, and even more typically $\pm 0.5\%$ of the stated value.

Throughout this disclosure, certain embodiments may be disclosed in a range format. It should be understood that the description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the disclosed ranges. Accordingly, the description of a range should be considered to have specifically disclosed all the possible sub-ranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have

specifically disclosed sub-ranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies
5 regardless of the breadth of the range.

Detailed Disclosure of embodiments

Exemplary, non-limiting embodiments of an automated
10 material dispensing system for dispensing material, such as medicine and food, to marine life and a method of automatically dispensing material into an aquarium for sustaining aquatic life will now be disclosed.

There is disclosed an automated material dispensing
15 system for dispensing material to marine life. Advantageously, the automated material dispensing system may be capable of dispensing a predetermined amount of material in a multi-layered array of containers. The material that is dispensed by the material dispensing
20 system may be fish feed, fish medications or a combination of fish feed and medication. In one embodiment, the automated material dispensing system dispenses fish feed. In another embodiment, the fish feed is in the form of a paste. The paste form fish food may
25 be the TetraFin™ FreshDelica Daphnia™ fish paste commercially available from Tetra Werke of Melle, Germany. Advantageously, the disclosed material dispensing system is capable of automatically dispensing fish food paste accurately, which may not be possible
30 with known automated fish feeding systems. Furthermore, the inherent viscosity of the fish paste advantageously

provides good control over dispensing of the fish paste during a dispensing operation. This is a particular advantage as the process is automated and relies on automated mechanisms, such as pneumatically operated syringes, actuated by automated means. For example, food in a dry form (ie dry food pellets) may be difficult to dispense accurately in an automated system because only a relatively small force needs to be applied by the automated dispenser. Furthermore, dry food may tend to float within the container containing the marine life, thereby leading to the food being dispensed predominantly to one part of the container.

The automated dispensing system comprises a plurality of containers capable of supporting marine life therein, each container and having a material intake portion for receiving material therein to be dispensed to said marine life. Advantageously, the containers are transparent to allow the user to monitor the marine life therein. Advantageously, when the marine life is comprised of aquatic plants, the transparent containers also allow light to reach the aquatic plants to ensure its viability. The containers may be of any shape but may be of a regular shape such as square, rectangular, circular and oval shape. Advantageously, the bottom of the container may be relatively flat so that it is able to rest on a planar surface with substantial stability, without the need for any additional support. The containers may be selected from the group containing tanks, bowls, bags, boxes, cups, jars, bottles, etc. In one embodiment, the containers are fish tanks. The containers may be made of polymers, copolymers, glass and

composite materials. The material intake portion may be a conduit provided on the container for receiving said material. In one embodiment, the material intake portion is the top of the container which does not contain a lid.

5 In another embodiment, the material intake portion may be a dedicated opening extending through one of a side wall or top of the container.

The automated dispensing system further comprises a material receptacle capable of containing said material
10 therein to be dispensed to said marine life.

The material receptacle of the material dispensing system may be of any particular shape that is suitable for containing the material to be dispensed. The material receptacle may be tubular, cylindrical, spherical,
15 cuboid, or irregularly shaped. Advantageously, the material receptacle may be substantially tubular in shape, which reduces the number of corners that may impede the movement or the dispensation of the material contained therein. Advantageously, the material
20 receptacle may comprise of an inner chamber and a reciprocating plunger within the chamber, which aids in the dispensing of material contained in the material receptacle. In one embodiment, the material receptacle is a syringe. In another embodiment, said syringe has an
25 ejection nozzle at its dispensing end. Advantageously, the diameter of the ejection nozzle is large enough to enable a desired pressure to be built up within the syringe. In one embodiment, the diameter of the ejection nozzle is from about 1mm to about 5 mm. In another
30 embodiment, the diameter of the ejection nozzle is about 2mm. In one embodiment, the dispensation of material from

the dispensing system is actuated by a pressure differential being applied within said syringe. In one embodiment, the dispensing means is selected from the group consisting of hydraulic pumps, pneumatic pumps and mechanical pumps.

The material receptacle may be made of any material that is capable of withstanding the pressures built up within the material receptacle during dispensing. The material receptacle may also withstand gripping forces from about 5 N to about 15 N without an appreciable change in its desired shape and properties.

Advantageously, the material receptacle may be impermeable to water and air as this reduces the possibility of contamination of the material contained therein. Advantageously, the material receptacle is non-reactive to its contents and made up of an inert material. Advantageously, the container is made up of a material that is non-toxic. The material receptacle may also be sterilized at temperatures of more than about 80°C and pressures at more than about 15 psi (~104 KPa), without an appreciable change in its desired form and properties.

In one embodiment the material receptacle is made of polymers. Said plastic materials may be selected from a group consisting of a polyvinyl resin, a vinyl acetate-ethylene copolymer, a vinyl polymer, an acrylic resin, a cellulose derivative and a polyolefin. Advantageously, said plastic material may be selected from the group consisting of poly(ethyl vinyl acetate), polyethylene, polypropylene, polystyrene and polyamide. The material receptacle may be manufactured by plastics molding, such

as cold molding, compression molding, injection molding etc.

The automated dispensing system further comprises a transport means for transporting said material receptacle to said material intake portions of each of said plurality of containers during a dispensing operation.

In one embodiment, the transport means of the automated material system comprises a track on which said material receptacle is capable of traveling along. The track is configured to allow said material receptacle to move in a three-dimensional space relative to its starting point, wherein the three dimensional space can be respectively defined by X, Y and Z Cartesian coordinate points. For example, the said material receptacle may move in a circular, spiral, zigzag, vertical, horizontal, diagonal or irregular path along the track. In one embodiment, the track is configured to allow said material receptacle to travel in at least one of a substantially vertical direction and a substantially horizontal direction relative to said plurality of containers. In another embodiment, the track is configured to allow said material receptacle to travel in a direction normal to said vertical direction. The track may be fixed or may be movable. The track may be any platform that aids the transportation of the material receptacle. The tracks may be rails, ball screws, guides, conveyor belts, rollers, wheels or any other means to aid movement. The tracks may be made of metal, polymers, copolymers or composites.

In one embodiment, the dispensing system comprises an moveable engaging means for moveable coupling of said

material receptacle along said track. In one embodiment the moveable engaging means comprises an arm coupling to the material receptacle and one or more rollers capable of moving along said track. The arm of the engaging means
5 may be an interconnecting set of links and joints moving with one or more degrees of freedom that can perform repetitious tasks involving manipulation and movement. The arm of the engaging means may exert a coupling force on the material receptacle from about 5 N to about 15 N.
10 Advantageously, the arm of the engaging means is able to couple firmly with the material receptacle without damaging it.

In one embodiment, the dispensing system comprises a motor to move said material receptacle along said track.
15 In another embodiment, the motor is actuated by a control means.

The control means for controlling movement of said material receptacle along said transport means and dispensation of said material to each of said plurality
20 of containers during said dispensing operation according to predetermined instructions.

The control means may incorporate a processor capable of interrogating a memory having predetermined instructors for moving and operating said material
25 receptacle. The control means may be linked to a user interface, such as a keyboard, and a graphical user interface such as a LCD display for allowing an operator to interact with the control means.

In one embodiment, the control means comprises a
30 memory having a computer algorithm thereon for storing said predetermined instructions. Advantageously, the LCD

display linked to the control means is touch sensitive and is capable of relaying user's instructions to the other components of the control means.

5 The control means may control the delivery of the material receptacle containing the material to be dispensed to specific locations by controlling the movements of the tracks or the movement of engaging means along the tracks. The control means may also control the timing, during and amount of each dispensation. The control means may also control the movement of the arm of the engaging means, tracks and mount that the material receptacles are disposed on. The control means may receive feedback from the sensor that senses the amount of contents that is within each material receptacle.

10 The control means may be able to store the dispensing history of the dispensing system. The control means may be able to store and process the dispensing parameters (i.e amount and duration) inputted by a user.

15 Advantageously the dispensing output is controlled by the control means. Various algorithms can be used in order to control the dispensing output. The system may use a predetermined program setting values as a starting point and over time these settings can be customized according to the user's requirements.

20 Advantageously, the control means has a learning ability to allow it to call on prior knowledge or memory to apply instantaneous settings. This learning ability is preferably encoded by software. The prior knowledge, or stored history, is based on past events, including dispensing rates and dispensing periods, and is stored in a temporary memory over a period of time. The dispensing

system itself may be monitored remotely by a hard wired communication link to the control means, or by radio communications or by means of a portable data log off.

5 In one embodiment, the automated dispensing system may comprise a mount for mounting said material receptacle. The mount may be made of polymers, copolymers, metals or a composite material. Advantageously, the mount may contain a plurality of holes or depressions that are capable of supporting or
10 holding a plurality of material receptacles. Advantageously, the mount of the material dispensing system may also be rotatable. This enables the material receptacles disposed on the mount to switch positions and the desired material receptacle may be presented to the
15 engaging means at any time. For example, when a material receptacle that is positioned to be coupled by the arm of engaging means does not contain the desired materials to be dispensed, the mount may be rotated such that another material receptacle which is filled with the desired
20 materials is presented to the engaging means for coupling and transport to the desired location. The mount may be able to rotate in the clockwise and anti-clockwise direction. The mount is able to rotate from an angle of about -360° to an angle of about 360° . The axis of
25 rotation may be within the mount or outside said mount.

In another embodiment, the mount is able to rotate at a speed of about $1/4$ rev/s to about 1 rev/s. In another embodiment, the torque exerted on the mount is from about 0.1 NM to about 0.3 NM. In one embodiment, the
30 mount is a turntable.

In another embodiment, the dispensing system may comprise a sensory means for sensing the amount of material in said material receptacle. The material dispensing system may incorporate multiple sensors coupled to said control means. The sensor may be any suitable sensing device capable of sensing the amount of material/contents contained in the material receptacle. The sensor may be an electronic sensor. In one embodiment, the sensor is selected from a group consisting of optical sensors, infra red sensors, pressure sensors, weight sensors and volume sensors. In one embodiment, the sensor and control means may communicate wirelessly or through wired connections.

The dispensing system is actuated to dispense said material mechanically or pneumatically.

The electrical components of said automated dispensing system may be insulated from undesired water entry.

The automated dispensing system may also be mounted on a supporting frame. The supporting frame may be made of polymers, copolymers, wood, metals or a composite material. The supporting frame may comprise of a plurality of wheels for easy translations. Advantageously, the wheels may be castor wheels. The supporting frame may also comprise of a plurality of legs which height can be adjusted to provide resisting means to translations. Advantageously, the supporting frame may be foldable or can be disassembled for easy storage and transportation.

Brief Description Of Drawings

The accompanying drawings illustrate a disclosed embodiment and serves to explain the principles of the disclosed embodiment. It is to be understood, however, that the drawings are designed for purposes of illustration only, and not as a definition of the limits of the invention.

Fig. 1 is a schematic diagram from a front perspective of an automated material dispensing system for marine life in accordance with one embodiment disclosed herein.

Fig. 2 is a schematic diagram of a lateral perspective of the automated material dispensing system of Fig. 1.

Fig. 3 is a schematic diagram on the flow of command signals to and from various components of the automated material dispensing system disclosed herein.

Fig. 4 is a flow chart on the algorithm that used by the control means in one embodiment of the automated material dispensing system disclosed herein.

Detailed Description

There is shown in Fig 1 and Fig 2, an automated material dispensing system 90 for dispensing material in the form of fish food paste to marine life.

The automated material dispensing system 90 comprises a plurality of containers, in the form of fish tanks (A-T) herein collectively shown by arrow 106. The fish tanks (A-T) are capable of supporting marine life in the form of fish therein. Each fish tank has an open top

which forms a material intake portion for receiving fish food paste therein to be dispensed to said marine life.

5 The fish tanks 106 are supported by supporting bases 128a of a fish tank rack 128. The first set of fish tanks (A-J) are located superior of a second set of fish tanks (K - T).

10 The automated material dispensing system 90 also comprises plurality material receptacles in the form of plural syringes 104. Each of the syringes 104 are capable of containing fish food paste therein to be dispensed to the fish.

15 The automated material dispensing system 90 also comprises a transport means in the form of horizontal tracks 102a, vertical tracks 102b and an engaging means 130, for transporting the syringe 104 to said material intake portions 106a of each of the fish tanks 106 during a dispensing operation.

20 The horizontal tracks 102a and vertical tracks 102b form an intersecting network that runs posterior to the fish tanks 106. The horizontal track 102a runs throughout the entire combined horizontal distance of the fish tanks (A-J or K-T) 106, while the vertical tracks run throughout the total vertical height of the fish tank rack 128. Horizontal track 102a is connected to a linear motion (LM) guide 130c which provides a rigid balance to
25 the horizontal track 102a.

30 An engaging means in the form of syringe engager 130 comprises a gripper 130f and a plugger 130e. A motor 130a that powers the timing belt mechanism of the horizontal tracks 102a and the ball screw mechanism of the vertical tracks 102b is located posterior to the vertical tracks.

The automated material dispensing system 90 also comprises a control means in the form of a programmable logic controller unit (PLC) (not shown) for controlling movement of the syringe 104 along the horizontal tracks 102a and vertical tracks 102b. The PLC also controls the dispensation of the fish food paste to each of the fish tanks 106 during the dispensing operation according to predetermined instructions that have been defined by the user of the system. Instructions from the user are sent to the PLC via a human machine interface (HMI) 134.

The human machine interface (HMI) 134 is located at the top corner of the material dispensing system 90. The HMI 134 comprises an LCD (liquid crystal display) screen 100 that relays visual information on the dispensing parameters such as the time, frequency and amount of fish food paste to be dispensed in each of the fish tanks 106, to the user. As shown by Fig. 3, the HMI 134 is capable of transmitting signals. Below the HMI 134, there is shown a set of turntables 132 for mounting the syringes 104. The turntables are able to move in a rotary motion to allow access to different syringes 104 to a gripper 130f. A sensor 136, is located beneath the gripper 130f and is able to detect the amount of fish paste that is contained in the syringes 104.

The fish tank rack 128, HMI 134, horizontal tracks 102a, vertical tracks 102b and turntables 132 are mounted on a supporting frame 116. The supporting frame 116 consists of four castor wheels 124 at its base for easy transportation or movement. The supporting frame 116 also has four adjustable legs 126 located at the corners of the base of the supporting frame that serve to provide a

sturdy support and to prevent undesired lateral movements of the supporting frame 116.

A water tank 114 is supported at the bottom of the supporting frame 116 and is fed by a water return pipe 118. The water return pipe 118 is connected to the supporting bases 128a of the fish tank rack 128 and drains overflowing water from the fish tanks 106 to the water tank 114. Water tank 114 provides a primary level of filtration by having a filter (not shown) being disposed within the tank 114 to filter any solid materials that may have found its way into the tank 114. Lying adjacent to the water tank 114, is a water pump 112 that pumps the water from the water tank 114 to a filter 110 situated next to the water pump 114. The filter 110 provides a secondary level of filtration. A pipe 108 connected to the outlet of the primary filter 110 feeds filtered water back to the fish tanks 106.

The operation of the material dispensing system 90 will now be disclosed.

The syringes 104 are first filled with fresh fish paste before starting the operation of the automated material dispensing system 90.

After the syringes 104 have been filled with fresh fish paste which is sold under the commercial name of TetraFin FreshDelica Daphnia™, they are mounted on the turntables 132. A power source is plugged to the PLC (not shown) and switched on. Using the touch sensitive LCD screen 100, the user is able to input and store the dispensing parameters for example the time and frequency of fish paste to be dispensed in each fish tank 106, into the PLC. The LCD screen 100, also provides the user with

visual information on the dispensing parameters that have been input and also visually updates the user on the status of the material dispensing system 90 (i.e. whether the material dispensing system 90 is in operation or when the next dispensing action will be). In summary, the HMI 134 provides a means of allowing a user to interface with the PLC. Most activities, such as dispensing frequency and dispensing amounts, have been preprogrammed on the PLC and the HMI 134 allows the user to invoke and/or cancel any of these activities.

Once the dispensing parameters have been input, the dispensing operation of material dispensing system 90 can be initiated by the user, using the touch sensitive LCD screen 100.

The PLC of the material dispensing system 90 assesses and assimilates the parameters that have been input by the user. Once the PLC reads that it is time for dispensing the fish food paste into the fish tanks 106, the PLC sends a signal to the gripper 130f of the syringe engager 130. The gripper 130f is activated and moves horizontally towards the syringe 104 that is mounted on the turntable 132. The gripper 130f then grips the syringe 104 and moves to remove the syringe 104 from the turntable 132. Once the syringe has been removed from the turntable, the plugger 130e moves towards the opening of the syringe 104 and plugs into it. The sensor 136 located at the bottom of the gripper 130f proceeds to sense the amount of fish paste available in the syringe 104 that is coupled to the gripper 130f. The sensor 136 then feedbacks that there is material present in the syringe 104, to the PLC. The PLC determines if the amount of fish

paste in the syringe 104 is sufficient. Relying on a computer algorithm stored within the memory of the PLC, the PLC then decides whether to return the gripper 130f mounted syringe (if empty) 104 to the turntable before
5 rotating the turntable 132 to present another syringe 104 to the gripper 130f. If the syringe 104 is empty, the PLC will send a signal to the plugger 130e which will retract and also send a signal to the gripper 130f which returns the syringe 104 back to the turntable 132.

10 Once the desired syringe 104 containing the desired amount of fish food paste has been coupled to the gripper 130f and the plugger 130e, the syringe 104 is then tilted by the tilter 130d to a horizontal position or a suitable angle before movement to the desired fish tank (A-T) for
15 discharge of the fish paste loaded therein.

Subsequently, another signal is sent from the PLC to the motor 130a. The motor 130a is then activated which in turn propels the ball screw mechanism (not shown) of the vertical track 102b and the timing track mechanism (not
20 shown) of the horizontal track 102a to direct the syringe engager 130 together with the syringe 104 to the desired location. When the desired location has been reached, the PLC sends a signal to halt movement of the syringe engager 130 along the horizontal track 130a.

25 Subsequently, the PLC sends another signal to plugger 130e of the syringe engager 130 to dispense a predetermined amount of fish food paste from the syringe 104 into the fish tank 106.

30 Thereafter, horizontal track 103a is reactivated by the PLC to transport the syringe 104 to the next desired horizontal location for dispensation.

The PLC will send the syringe 104 back to the starting position (near the turntable 132) periodically so that the sensor 136 can reevaluate the contents left in the syringe 104. The control unit will then decide
5 whether the syringe 104, which is to be coupled to the syringe engager 130, should be replaced by another one.

The entire process is repeated until the desired amount of fish food paste has been dispensed in each fish tank 106 in each dispensing cycle.

10 Throughout the entire dispensing operation, the water pump 112 pumps the water from the water tank 114 to the inlet of the filter 110 situated next to the water pump 114. The water passes through the filters present in (not shown) the water tank 114 for a primary level of
15 filtration, and then to the filter 110 for a secondary level of filtration of particles which are small enough to pass through the primary level of filtration are filtered in the second level of filtration, before being pumped back to the fish tanks 106. When the fish tanks
20 106 are continuously being filled with the water that is pumped into it, the excess water overflows the fish tanks 106 and is drained to the water tank 114 via the water return pipe 118. Advantageously, this water recycling and filtering process reduces contamination of the water used
25 to sustain marine life without the need for constant water replenishment.

Referring to Fig. 3, there is shown a schematic flow chart of signals to and from the different components of the automated material dispensing system disclosed
30 herein. The HMI 134 together with the sensor 136, provide input electrical signals to the PLC 200. The PLC 200 then

assesses the input signals and where appropriate, sends output electrical signals to the turntable 132, the motor 130a and the syringe engager 130. The turntable 132 either turns or halts due to the signal transmitted from the PLC 200. According to the signal sent from the PLC 200, the motor 130a, propels and move the syringe along the vertical track 102b and the horizontal track 102a to the desired location. The gripper 130f of the syringe engager 130 moves to grip a syringe; the tilter 130d of the syringe engager 130 moves to tilt the syringe; and the plugger 130e is activated to eject a desired amount of material from the syringe, upon receipt of an appropriate signal from the PLC 200.

In accordance to Fig. 4, there is shown a schematic flow chart of an algorithm that is used by the control means of the one embodiment of the automated material dispensing system 90. In this programmed protocol, there are various steps of assessment made by the control means. When the automated system is started (Step S1), it first will assess whether it is time for the dispensing operation to be carried out. If affirmative (S2), the next assessment would be on whether the amount of contents in the syringe 104 is adequate for dispensation into the fish tanks 106 (S3). If negative (S7), then the system 90 waits until the pre-programmed dispensing time arrives (S8) at which time the step S1 is repeated.

If the contents are deemed sufficient (S4), the dispensing operation is allowed to proceed with the next step of assessment, which is to move the syringe 104 to the desired location (S9) and monitor whether the location is reached (s10). If the desired location is

reached (S11) the fish paste is dispensed from the syringe 104 at step (S12) before the step (S3) is repeated and the process stops (S15) when all fish tanks 106 have been charged with fish paste. At step (S10), if
5 the desired location is not reached (S11) syringe 104 continues to move (S14) until the desired location has been reached (S11).

At step (S5), if the contents are deemed to be insufficient then the syringe is moved to the turntable
10 132 (S6) for replacement with a filled syringe as described above.

15 Applications

It will be appreciated that the automated material dispensing system disclosed herein is a simple yet efficient and useful system for delivering a precise amount of material to a plurality of fish tanks regularly
20 at precise time intervals.

The disclosed system may enable a relatively precise amount of food to be dispensed to the fish at scheduled times. This is particularly advantageous for raising young, first feeding fishes and certain more vulnerable
25 fish species. For example, the disclosed system can be used to accurately feed Zebra fish and Medaka, which are somewhat sensitive to overfeeding and underfeeding. Hence, the disclosed system can be utilized by research institutions to maintain accurate and consistent
30 experimental conditions (ie such as feeding quantity) to achieve reliable and reproducible experimental results.

The disclosed system can replace manual systems for dispensing material to marine life. Hence, the disclosed system will not require such a large amount of manpower and time to dispense the material to the fish compared to manual systems.

The disclosed system therefore does not require that an operator be available to feed the fish according to any strict feeding regime because such a feeding regime is already programmed into the control means.

The disclosed system does not require a dispensing unit located adjacent to each fish tank.

Advantageously, since the automated material dispensing system is controlled by a control means, the automation of the dispensing is precise and accurate without the need of constant monitoring.

Advantageously, the control means, which is feedbacked by a sensor, is able to alert the user whenever a material receptacle requires a top up of contents.

Advantageously, the control unit is programmable by the user and is able to follow a customized dispensing pattern unique to each user or fish tank.

Advantageously, because the dispensing of dispensations is carried out by an applied pressure differential, highly viscous contents such fresh fish food paste can be automatically dispensed into the aquarium tanks. More advantageously, since fresh fish food paste, which usually has higher nutritional value than dry fish food, can be used, the fish fed with the food paste using the disclosed automated material dispensing system, will have a more salubrious diet. This

translates to healthier fish that have a higher chance of survival.

Advantageously, different types of materials can be dispensed into each fish tank since more than one
5 syringes can be used in the system. Each syringe can be filled with a different type of content. For example, each of the syringes can be filled up with different fish feed or fish supplements so that each fish tank can have a different type of content dispensed into it from the
10 individual syringes during the dispensing operation. Hence, advantageously the automatic dispensing system is able to automatically feed an array of fish tanks each harbouring a different fish species.

Advantageously, because the tracks runs in
15 substantially horizontally and vertically relative to the fish tanks, in a three dimensional space, a multi-layered array of fish tanks can be fed by the automated material dispensing system. Since the fish tanks can be stacked on top of each other in a multi-layered array, a large
20 amount of floor area can be saved.

While reasonable efforts have been employed to describe equivalent embodiments of the present invention, it will be apparent to the person skilled in the art after reading the foregoing disclosure, that various
25 other modifications and adaptations of the invention may be made therein without departing from the spirit and scope of the invention and it is intended that all such modifications and adaptations come within the scope of the appended claims.

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Claims

1. An automated material dispensing system for dispensing material to marine life, the system comprising:

a plurality of containers capable of supporting marine life therein, each container and having a material intake portion for receiving material therein to be dispensed to said marine life;

a material receptacle capable of containing said material therein to be dispensed to said marine life;

a transport means for transporting said material receptacle to said material intake portions of each of said plurality of containers during a dispensing operation; and

a control means for controlling movement of said material receptacle along said transport means and dispensation of said material to each of said plurality of containers during said dispensing operation according to predetermined instructions, wherein said dispensation of said material is actuated by a pressure differential being applied within said material receptacle.

2. The dispensing system as claimed in claim 1, wherein said material is food for said marine life.

3. The dispensing system as claimed in claim 2, wherein said food is in the form of a paste.

4. The dispensing system as claimed in claim 1, wherein said material receptacle is tubular in shape.

5. The dispensing system as claimed in claim 4, wherein said tubular-shaped material receptacle is a syringe.
- 5 6. The dispensing system as claimed in claim 5, wherein said syringe has an ejection nozzle at its dispensing end.
- 10 7. The dispensing system as claimed in claim 6, wherein the diameter of said ejection nozzle is from 1 mm to 5 mm.
- 15 8. The dispensing system as claimed in claim 1, wherein said transport means comprises a track on which said material receptacle is capable of traveling on.
- 20 9. The dispensing system as claimed in claim 8, wherein said track is configured to allow said material receptacle to travel in at least one of a substantially vertical direction and a substantially horizontal direction relative to said plurality of containers.
- 25 10. The dispensing system as claimed in claim 9, wherein said track is configured to allow said material receptacle to travel in a substantially normal direction to said vertical direction.
- 30 11. The dispensing system as claimed in claim 8, comprising a moveable engaging means for moveable

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coupling of said material receptacle along said track.

5 12. The dispensing system as claimed in claim 11, wherein said moveable engagement means comprises an arm coupling to the material receptacle and said moveable engagement means is capable of moving along said track.

10 13. The dispensing system as claimed in claim 11, further comprising a motor to move said material receptacle along said track.

15 14. The dispensing system as claimed in claim 13, wherein said motor is actuated by said control means.

20 15. The dispensing system as claimed in claim 1, wherein said control means comprises a memory having an computer algorithm thereon for storing said predetermined instructions.

25 16. The dispensing system as claimed in claim 1, wherein said pressure differential is supplied by a device selected from the group consisting of

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hydraulic pumps, pneumatic pumps and mechanical pumps.

5 17.The dispensing system as claimed in claim 1,
further comprising sensory means for sensing the
amount of material in said material receptacle.

10 18.The dispensing system as claimed in claims 1,
further comprising a mount for mounting said
material receptacle.

15 19.The dispensing system as claimed in claims 1,
wherein a plurality of said material receptacles are
disposed on said mount for dispensing plurality
material.

20 20.The dispensing system as claimed in claim 19,
wherein said mount is rotatable to allow said
plurality of material receptacles to be rotated.

21.An automated method of dispensing material to
marine life comprising:

25 a) providing a plurality of containers capable of
supporting marine life therein, each of said
containers having a material intake portion for
receiving material therein to be dispensed to
said marine life;

30 b) moving, under direction of a controller
according to predetermined instructions, a
receptacle containing said material to be

dispensed to said material intake portions of each of said containers; and

5 c) dispensing, under direction of said controller according to said predetermined instructions, said material while said receptacle is located at each of said material intake portions, wherein said dispensation of said material is actuated by a pressure differential being applied within said material receptacle.

10 22. An automated method as claimed in claim 21, comprising the step of:

d) filling said receptacle with said material while at a material filling point.

15 23. An automated method as claimed in claim 22, comprising the step of:

20 e) detecting the amount of material within said receptacle to determine when said filling step (d) should be undertaken.

25 24. An automated material dispensing system for dispensing material to a plurality of containers capable of supporting marine life therein, each container and having a material intake portion for receiving material therein to be dispensed to said marine life, the system comprising:

30 a material receptacle capable of containing said material therein to be dispensed to said marine life;

a transport means for transporting said material receptacle to said material intake portions of each of said plurality of containers during a dispensing operation; and

a control means for controlling movement of
said material receptacle along said transport
means and dispensation of said material to each
of said plurality of containers during said
dispensing operation according to predetermined
instructions, wherein the dispensation of said
material is activated by a pressure differential
being applied with said material receptacle.

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