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(54) **METHODS AND SYSTEMS FOR CONTROLLED SOIL-LESS PLANT GROWING**

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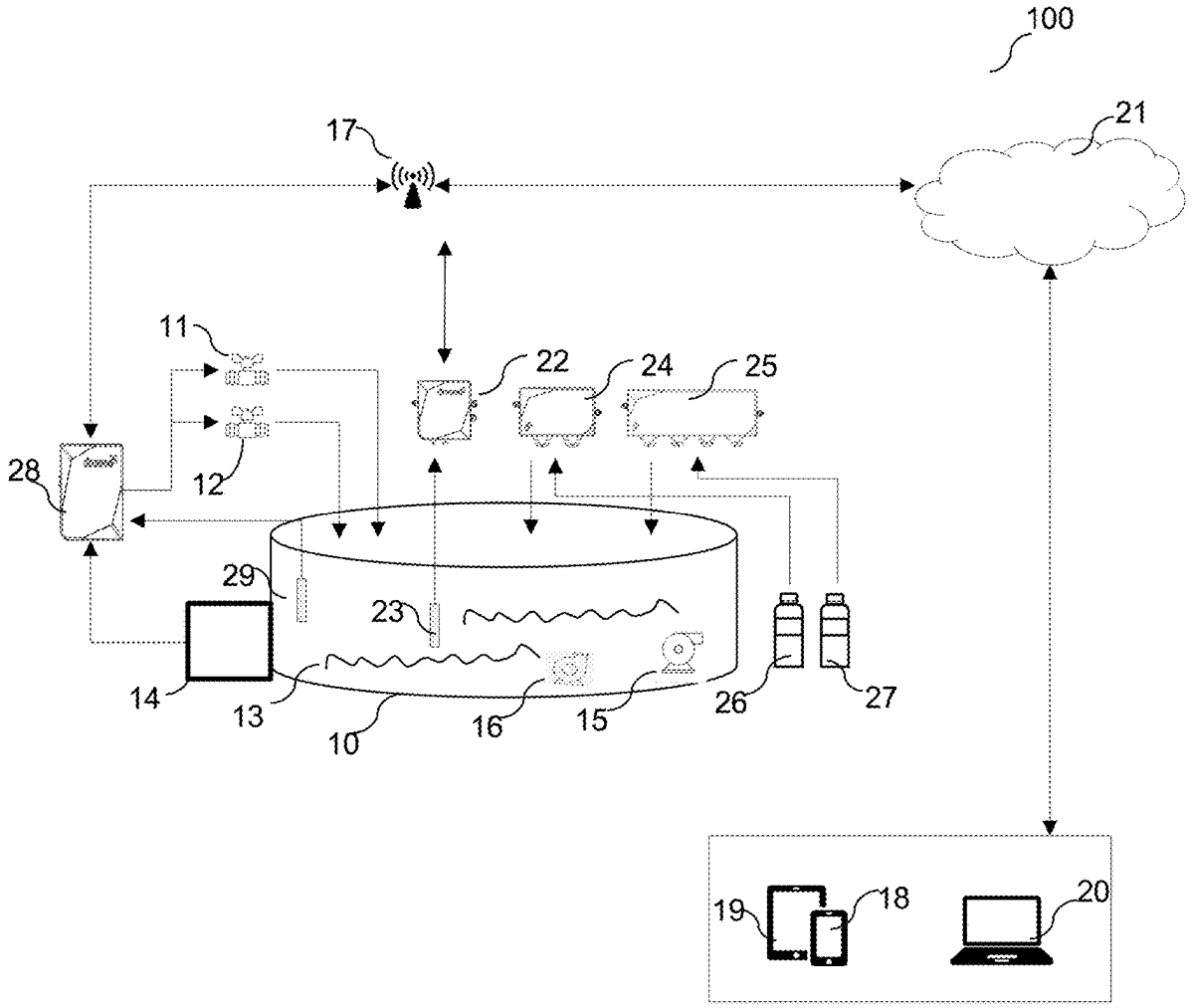
(52) **U.S. Cl.**
CPC ***A01G 31/011*** (2025.01)

(57) **ABSTRACT**

The present disclosure relates generally to controlled hydroponic plant growing systems.



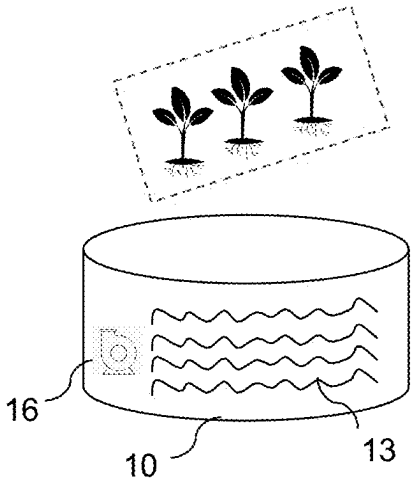


FIG. 1A

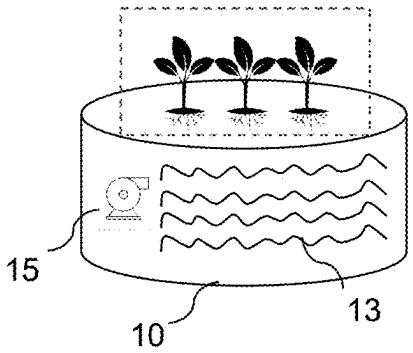


FIG. 1B

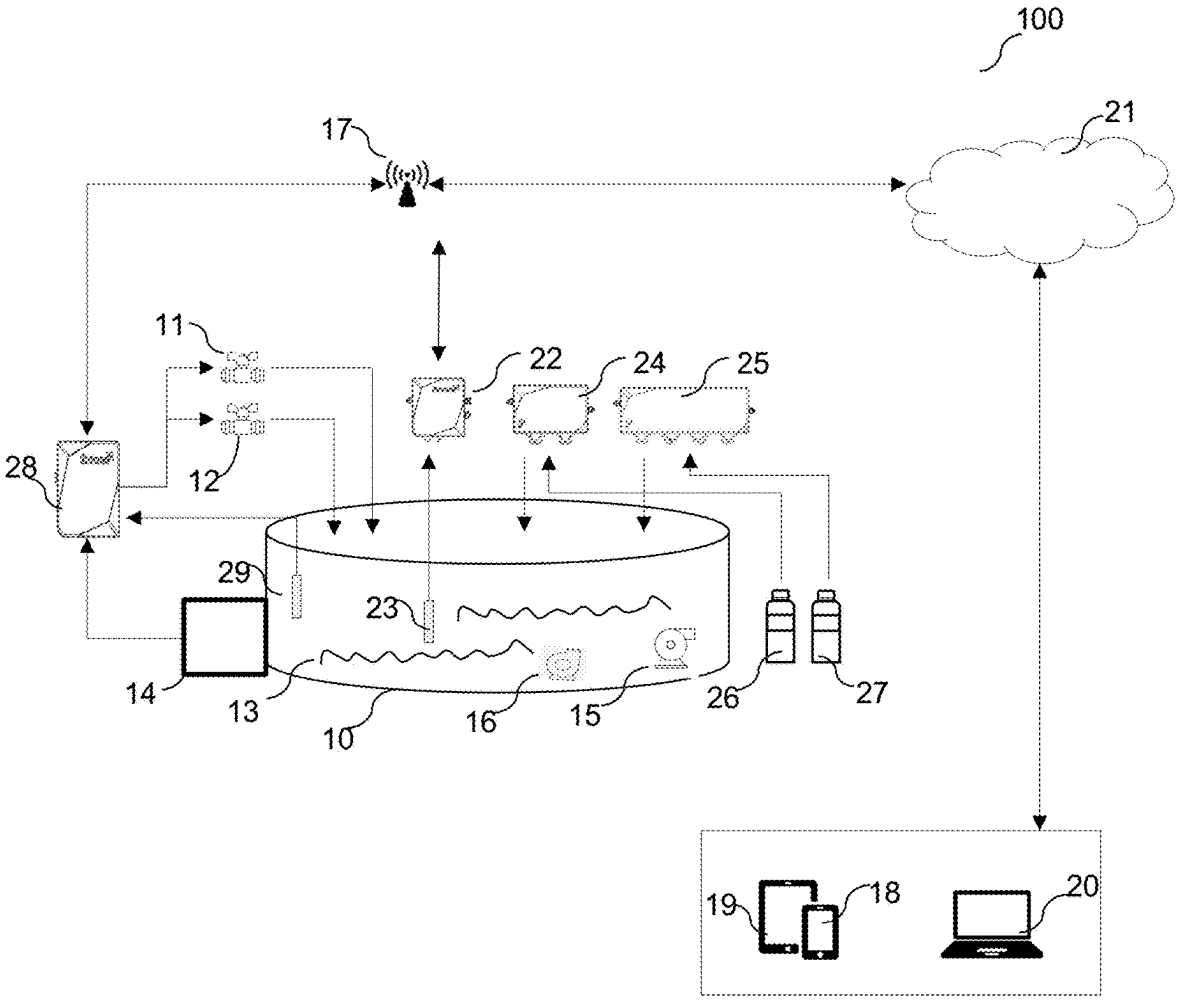


FIG. 2

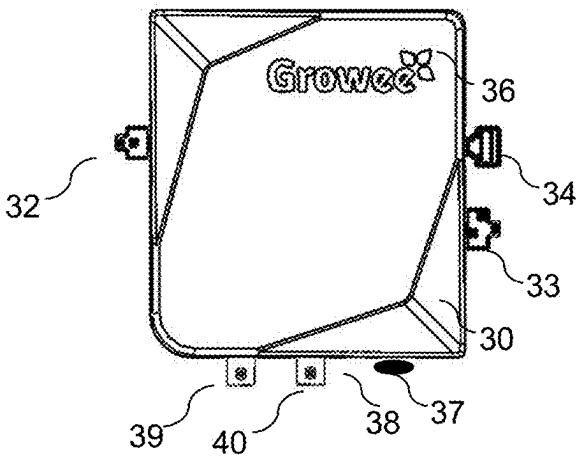


FIG. 3A

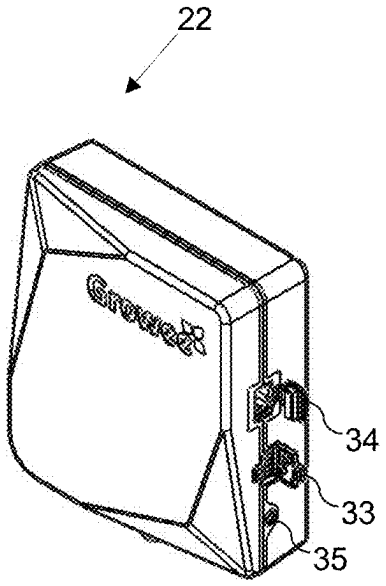


FIG. 3B

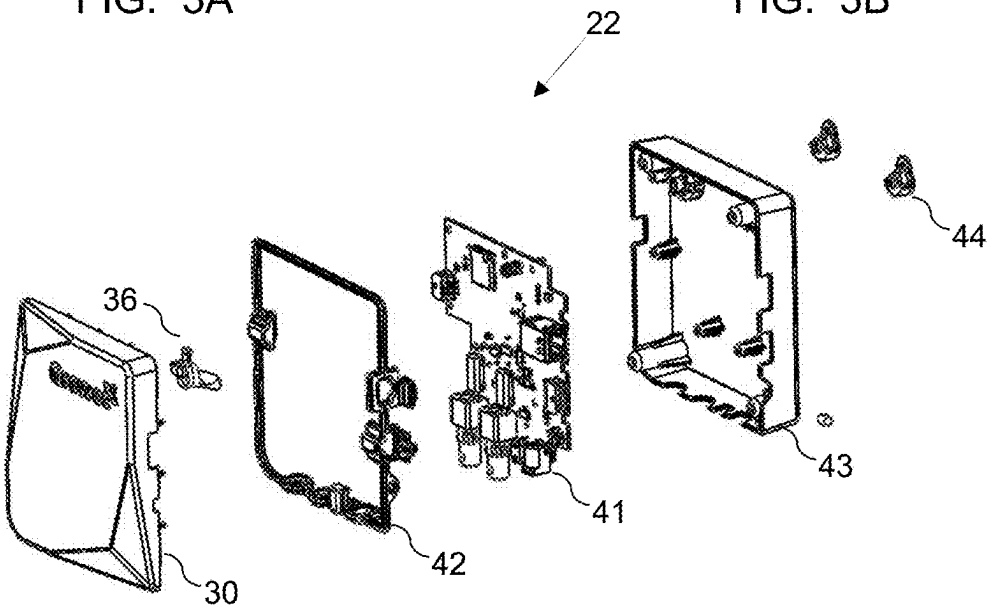


FIG. 4

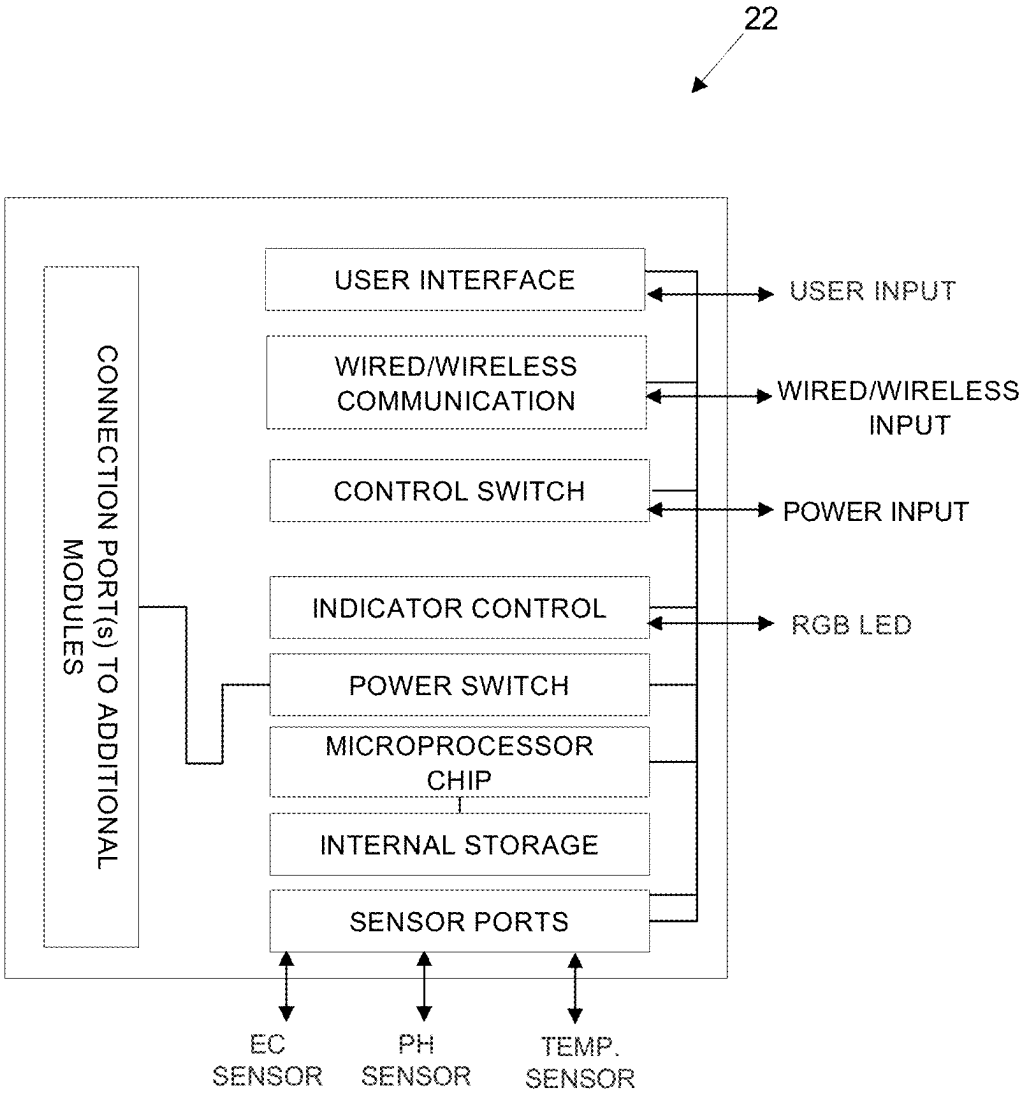

22
CONNECTION PORT(s) TO ADDITIONAL MODULES
USER INTERFACE
USER INPUT
WIRED/WIRELESS COMMUNICATION
WIRED/WIRELESS INPUT
CONTROL SWITCH
POWER INPUT
INDICATOR CONTROL
RGB LED
POWER SWITCH
MICROPROCESSOR CHIP
INTERNAL STORAGE
SENSOR PORTS
EC SENSOR
PH SENSOR
TEMP. SENSOR

FIG. 5

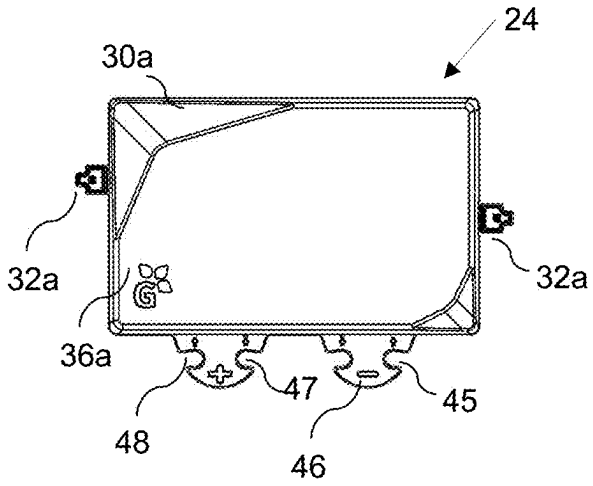


FIG. 6A

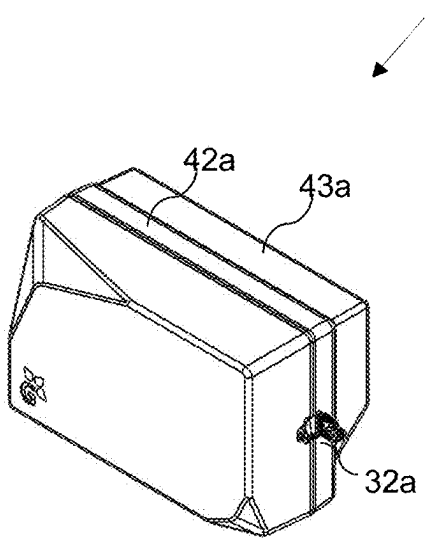


FIG. 6B

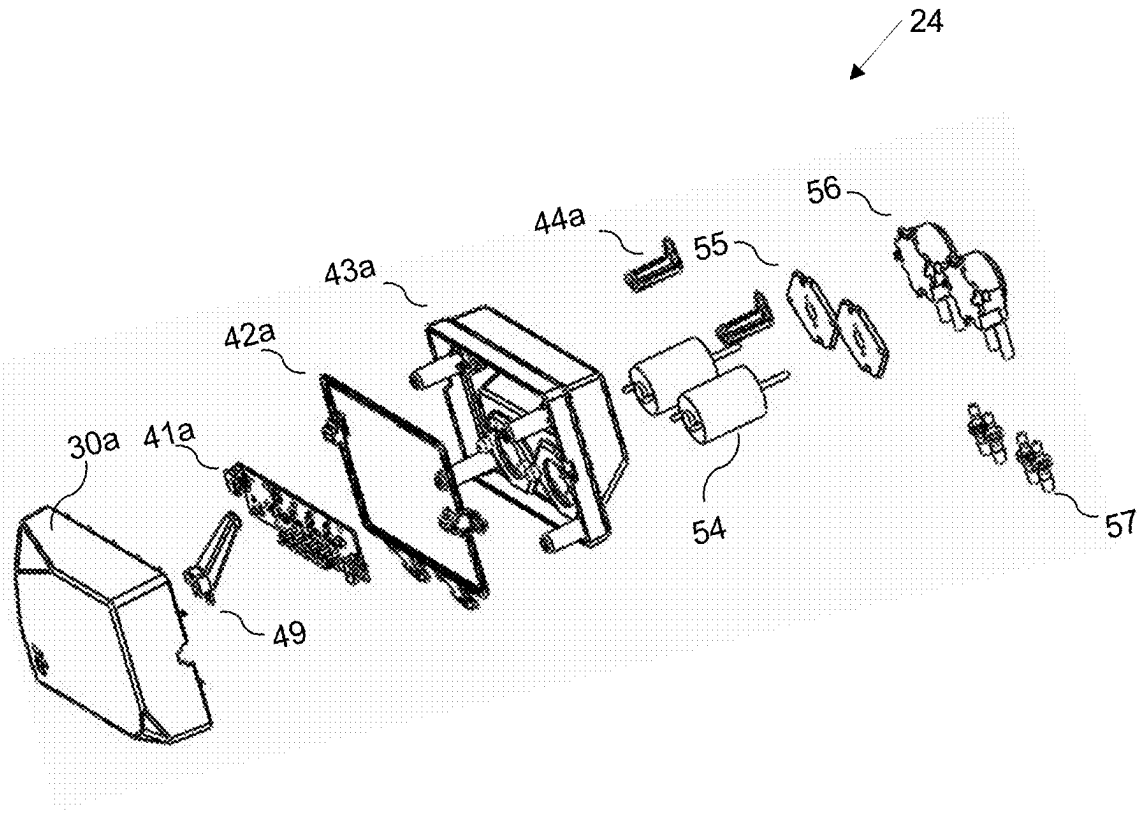


FIG. 7

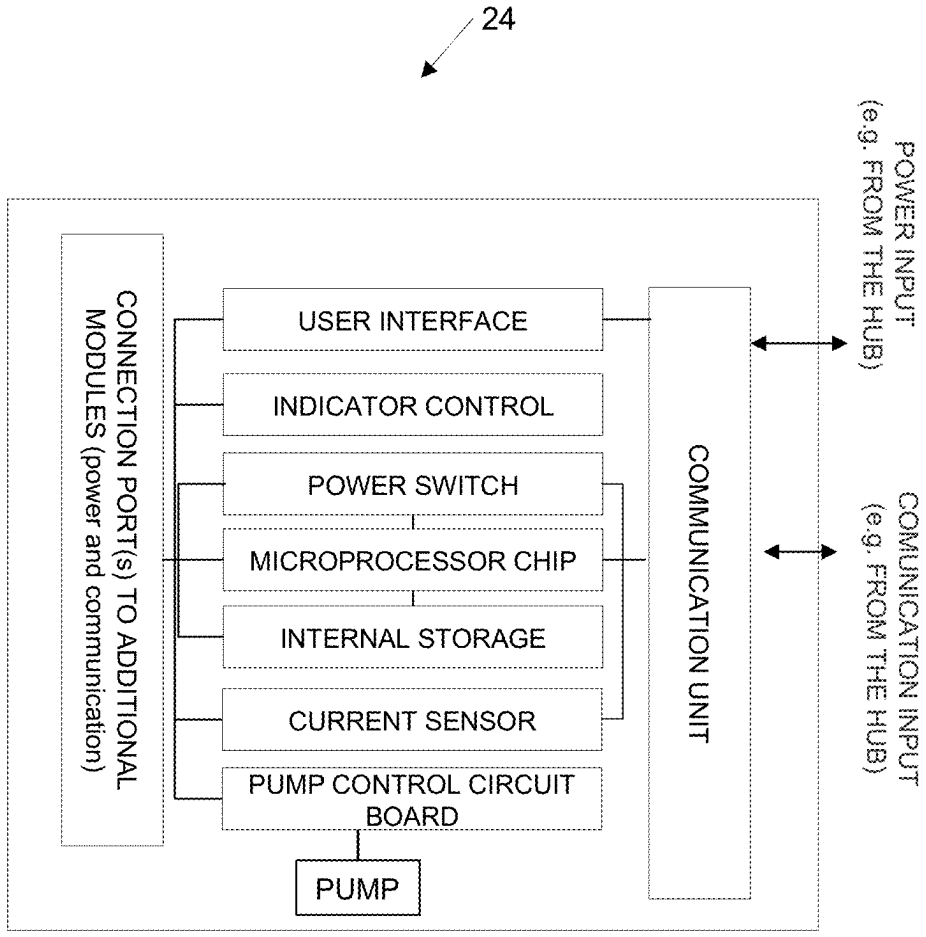

24
POWER INPUT (e.g. FROM THE HUB)
COMMUNICATION INPUT (e.g. FROM THE HUB)
CONNECTION PORT(s) TO ADDITIONAL MODULES (power and communication)
USER INTERFACE
INDICATOR CONTROL
POWER SWITCH
MICROPROCESSOR CHIP
INTERNAL STORAGE
CURRENT SENSOR
PUMP CONTROL CIRCUIT BOARD
PUMP
COMMUNICATION UNIT

FIG. 8

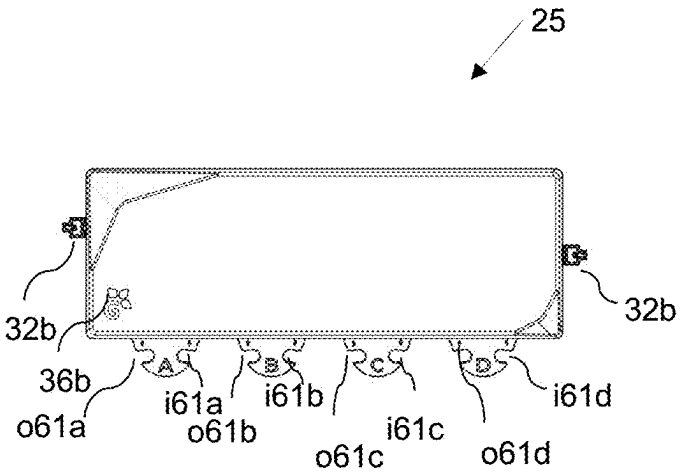

25
32b
32b
36b
o61a
i61a
o61b
i61b
o61c
i61c
o61d
i61d

FIG. 9A

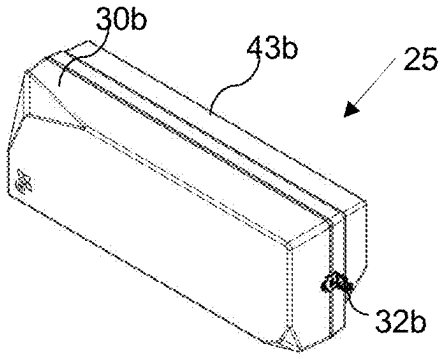

30b
43b
25
32b

FIG. 9B

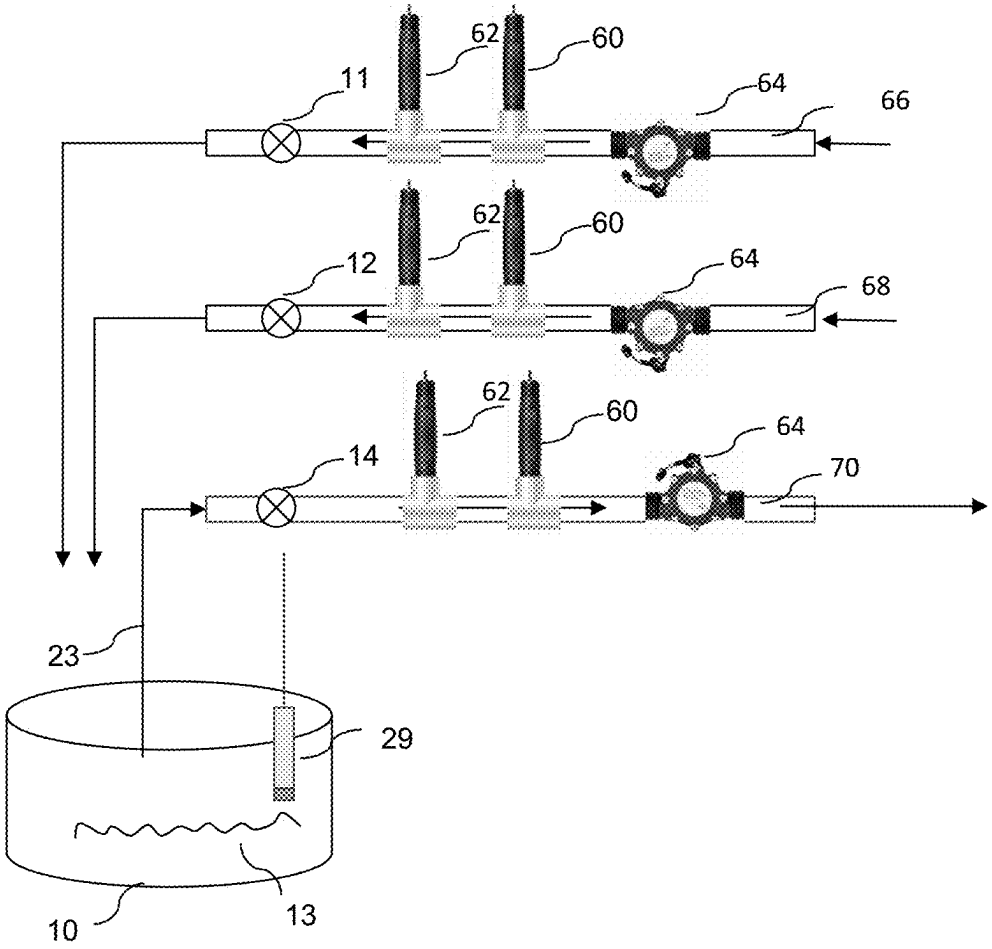


FIG. 10

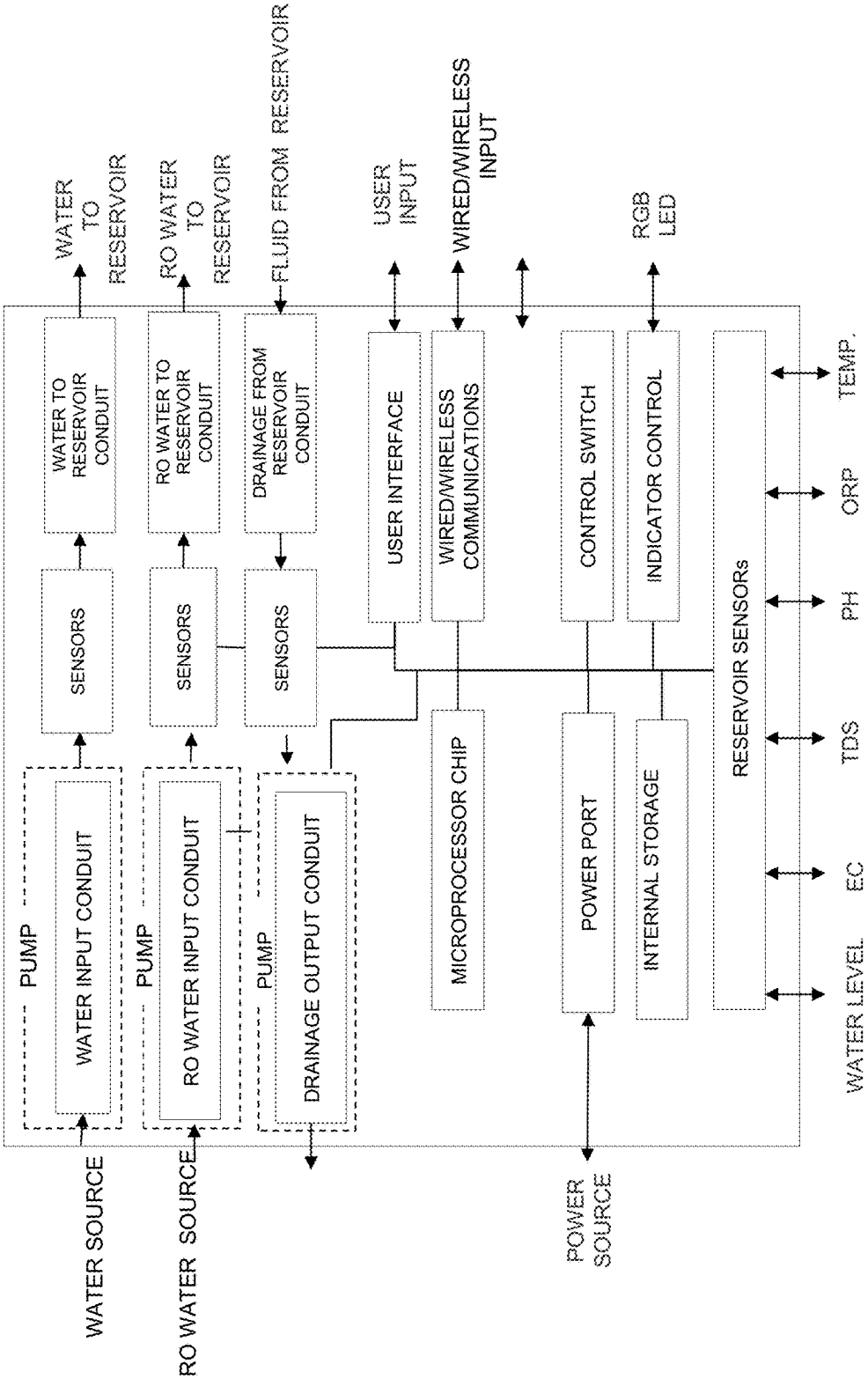

WATER SOURCE
RO WATER SOURCE
POWER SOURCE
PUMP
WATER INPUT CONDUIT
PUMP
RO WATER INPUT CONDUIT
PUMP
DRAINAGE OUTPUT CONDUIT
SENSORS
SENSORS
SENSORS
WATER TO RESERVOIR CONDUIT
RO WATER TO RESERVOIR CONDUIT
DRAINAGE FROM RESERVOIR CONDUIT
WATER TO RESERVOIR
RO WATER TO RESERVOIR
FLUID FROM RESERVOIR
USER INTERFACE
WIRED/WIRELESS COMMUNICATIONS
MICROPROCESSOR CHIP
POWER PORT
INTERNAL STORAGE
CONTROL SWITCH
INDICATOR CONTROL
RESERVOIR SENSORS
USER INPUT
WIRED/WIRELESS INPUT
RGB LED
WATER LEVEL
EC
TDS
PH
ORP
TEMP.

FIG. 11

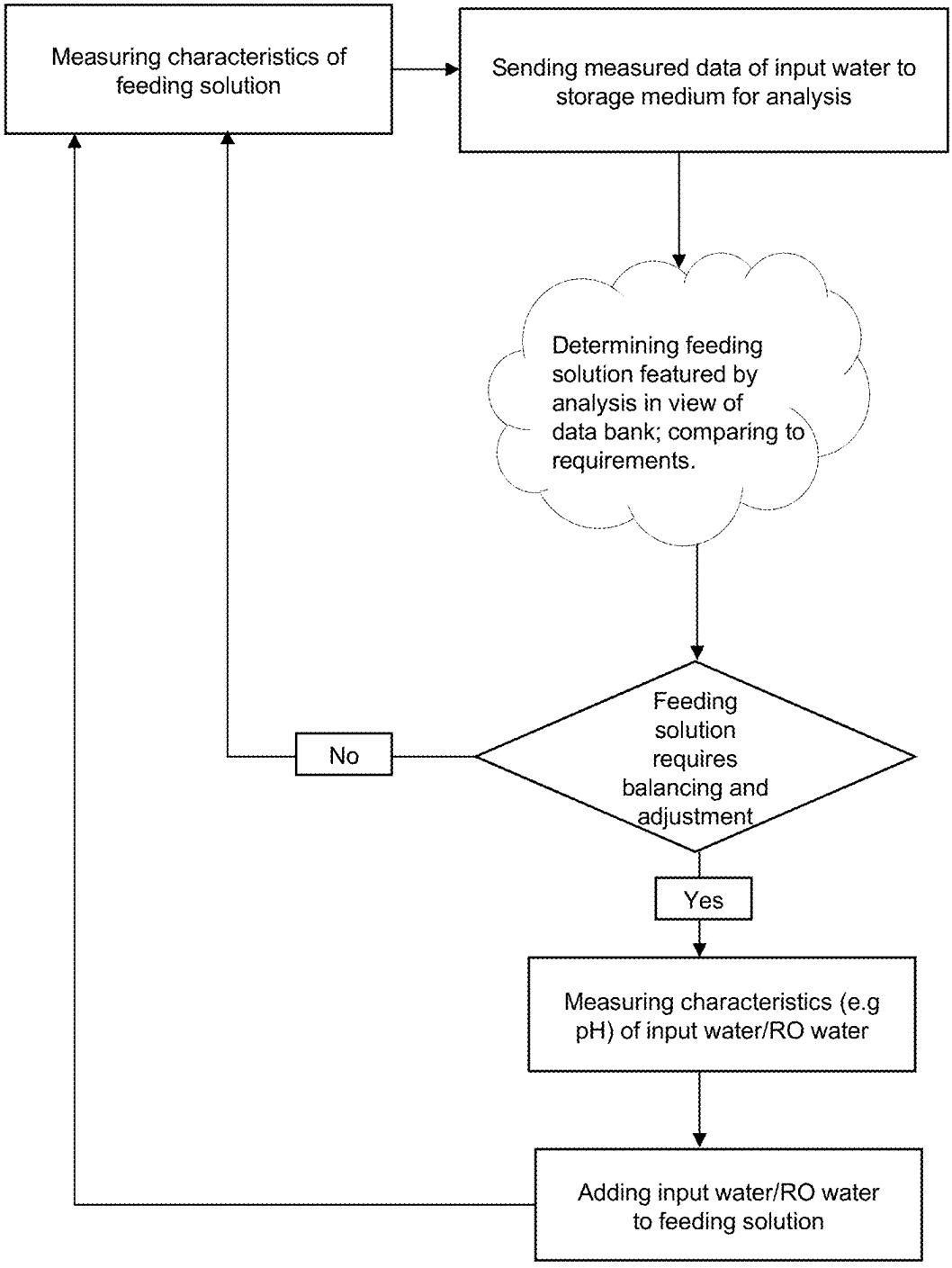

Measuring characteristics of feeding solution
Sending measured data of input water to storage medium for analysis
Determining feeding solution featured by analysis in view of data bank; comparing to requirements.
Feeding solution requires balancing and adjustment
No
Yes
Measuring characteristics (e.g pH) of input water/RO water
Adding input water/RO water to feeding solution

FIG. 12

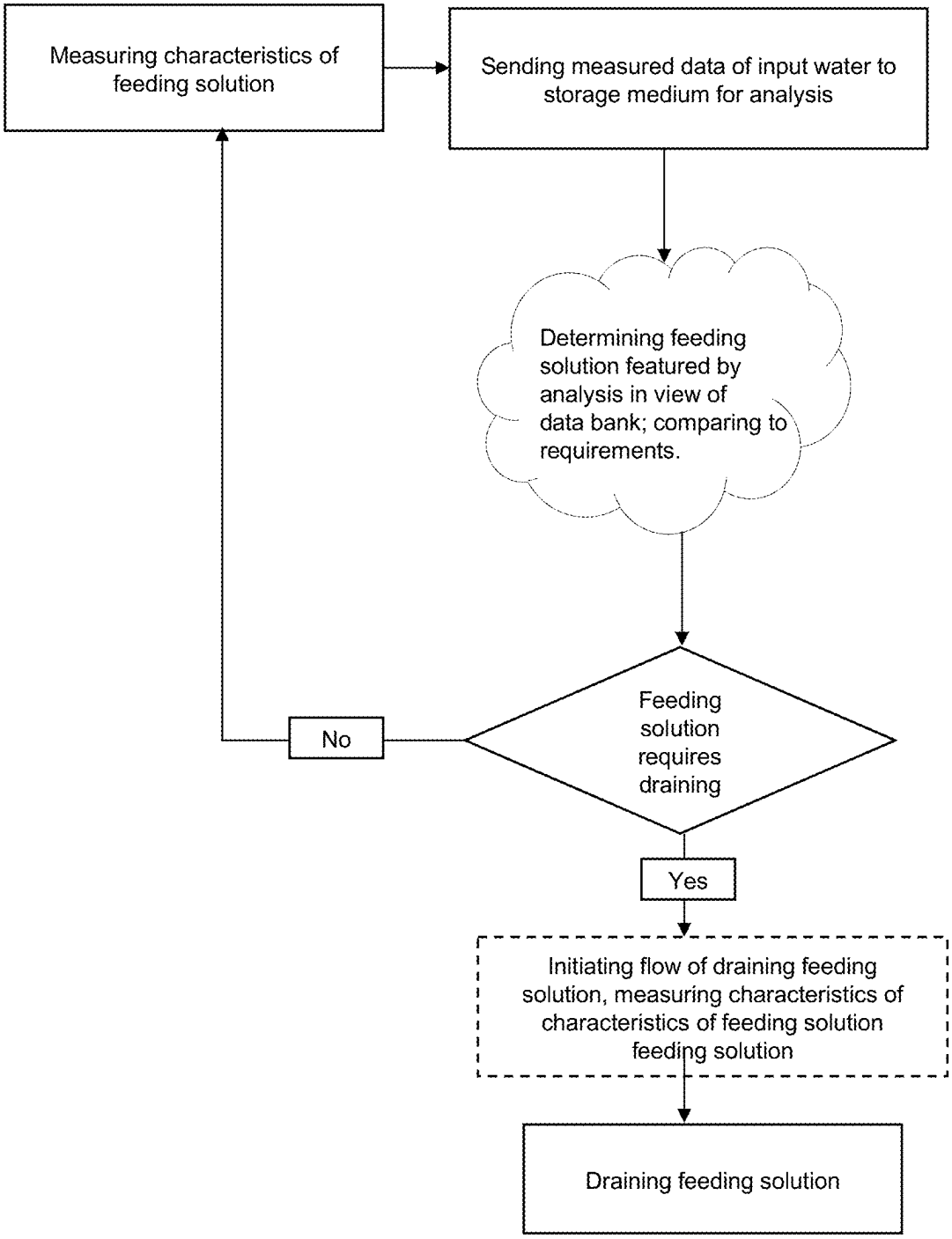

Measuring characteristics of feeding solution
Sending measured data of input water to storage medium for analysis
Determining feeding solution featured by analysis in view of data bank; comparing to requirements.
Feeding solution requires draining
No
Yes
Initiating flow of draining feeding solution, measuring characteristics of characteristics of feeding solution feeding solution
Draining feeding solution

FIG. 13

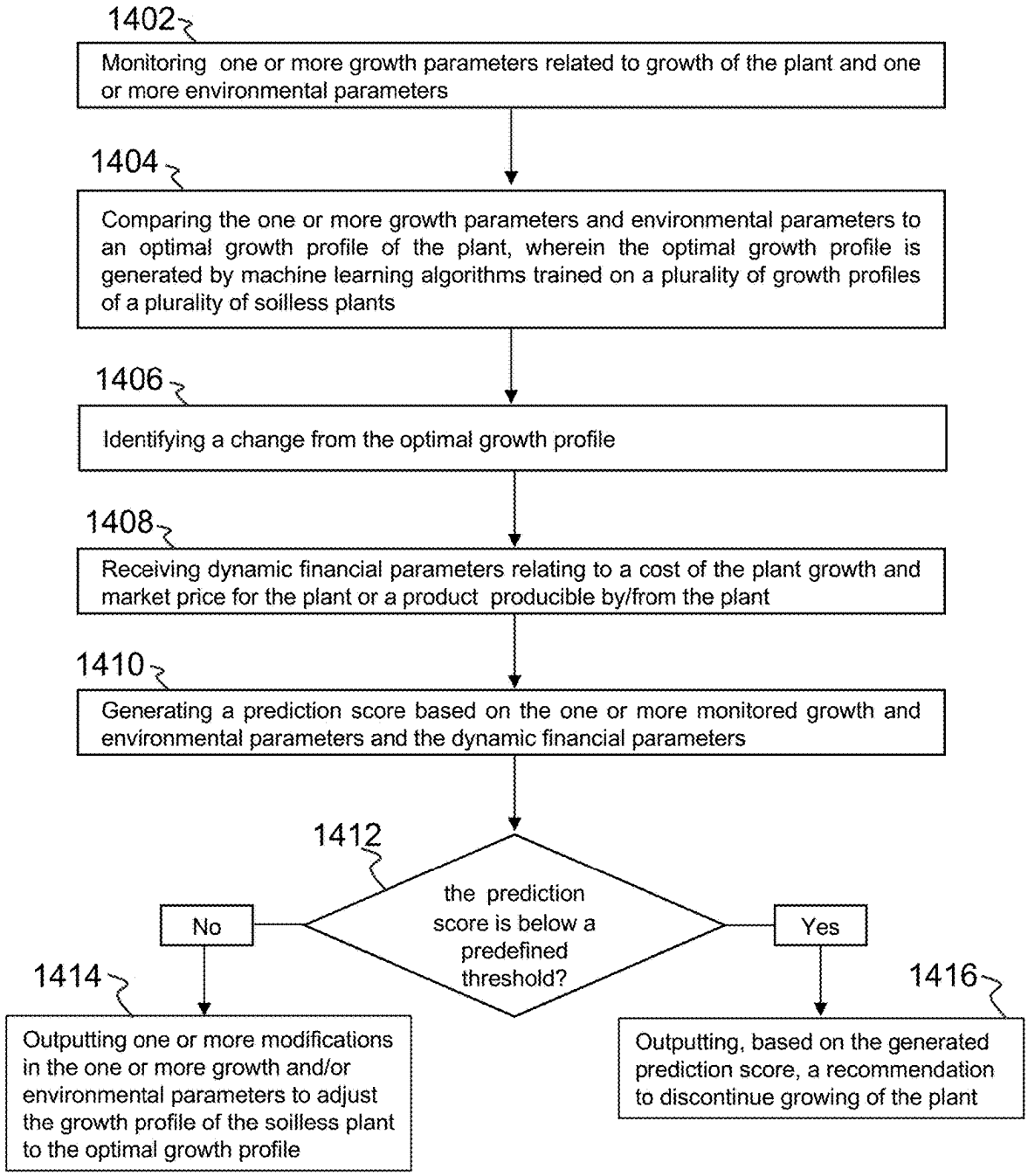

1402
Monitoring one or more growth parameters related to growth of the plant and one or more environmental parameters
1404
Comparing the one or more growth parameters and environmental parameters to an optimal growth profile of the plant, wherein the optimal growth profile is generated by machine learning algorithms trained on a plurality of growth profiles of a plurality of soilless plants
1406
Identifying a change from the optimal growth profile
1408
Receiving dynamic financial parameters relating to a cost of the plant growth and market price for the plant or a product producible by/from the plant
1410
Generating a prediction score based on the one or more monitored growth and environmental parameters and the dynamic financial parameters
1412
the prediction score is below a predefined threshold?
No
Yes
1414
Outputting one or more modifications in the one or more growth and/or environmental parameters to adjust the growth profile of the soilless plant to the optimal growth profile
1416
Outputting, based on the generated prediction score, a recommendation to discontinue growing of the plant

FIG. 14

METHODS AND SYSTEMS FOR CONTROLLED SOIL-LESS PLANT GROWING

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a Continuation-in-Part of U.S. patent application Ser. No. 17/604,266, filed Oct. 15, 2021, which is a National Phase of PCT Patent Application No. PCT/IL2020/050454 having International filing date of Apr. 16, 2020, which claims the benefit of priority of U.S. Provisional Patent Application No. 62/835,541, filed Apr. 18, 2019, the contents of which are all incorporated herein by reference in their entirety.

TECHNICAL FIELD

[0002] The present disclosure relates generally to controlled hydroponic plant growing systems.

BACKGROUND OF THE INVENTION

[0003] Soilless agriculture/Hydroponics is the science of growing plants without soil. Hydroponics offers clear advances over soil, such as reduced water consumption and faster growth cycle. In recent years, hydroponics has become much more popular due to the limited space in most urban environments. Hydroponic systems offer an economical solution by allowing the utilization of unused space such as rooftops of urban buildings.

[0004] A soilless/hydroponic system typically has one or more water reservoirs encompassing plants' feeding solution(s). Water pH and the amount of nutrients and fertilizers in the water must be monitored and controlled in order to continuously meet the required conditions, during all stages of plant growth, of any plant strain under any environmental conditions. Wrong fertilizers, dose of additives (e.g. minerals) and/or wrong pH could cause damage to plant's yield and even lead to plant death.

[0005] There is an unmet need for systems and methods that continuously monitor the quality and contents of soilless feeding solution, and adjust the various parameters, such as, pH, nutrients, fertilizer and minerals, in real time, thereby avoiding replacement of the entire feeding solution in a reservoir.

SUMMARY OF THE INVENTION

[0006] Aspects of the disclosure, according to some embodiments thereof, relate to intelligent nutrients modeling and feeding algorithm for soil-less/hydroponic growing methods and to systems utilizing same. More specifically, but not exclusively, aspects of the disclosure, according to some embodiments thereof, relate to:

[0007] Provided herein is a system and use thereof for hydroponic gardening, configured to continuously monitor and adjust pH and nutrients levels of plants soil-less growing media, also termed herein feeding solution, as well as temperature (e.g. of air, growing media, and irrigation water), while avoiding replacement of the entire feeding solution in a reservoir, thereby provided cost-effective and intelligent technology.

[0008] The methods disclosed herein include tracking water pH and minerals concentration (ppm). The tracked data is used by the system for determining the exact volume and contents of the fluids that need to be added to a feeding solution for replenishing it and for reaching desired preset values. In addition, the tracked data is used for creating models that can be used for predicting changes in the feeding solution, and using the prediction for intelligent management of the feeding solution during all stages of plant growth, thereby avoiding crisis, fatal changes in the feeding solution, and hence saving funds and time in soilless plant growth.

[0009] Thus, the system and methods disclosed herein are configured to provide dynamic plant feeding based on the measured parameters.

[0010] Advantageously, the system and methods disclosed herein are configured for delicate, partial replacement of the feeding solution based on the measured data, thereby providing a cost-effective solution to the problem of soilless plant growth.

[0011] The system disclosed herein comprises various components providing sophisticated, customized, yet, user friendly, control of the parameter required for soilless gardening, including, but not limited to, nutrients, pH, feeding solution level (amount) among others. Advantageously, the system and methods disclosed herein provide selective layers of functionality, some of which can be easily operated by layman, via a simple user-friendly interface. The system provides advanced automated technology for soilless plant growing that operates in the background of the daily functions. For example, the system uses multi-sensor technology to continuously "learn" the conditions that yield best/optimal plant's growth, using the collected data for optimizing the plant growth conditions. The ability of the system to continuously, or periodically, monitor in real time the various parameters involved in plant growth and deduce the best conditions, enables to significantly reduce growth time, nutrients consumption, failure rate and fertilizer waste.

[0012] In some embodiments, there is provided a system for monitoring and maintaining a balanced plant soilless feeding solution comprising a server comprising a data bank, and a hydroponic device connected to at least one sensor, the hydroponic device comprising

[0013] at least one microprocessor;

[0014] at least one communication board in communication with the server;

[0015] at least one sensor port;

[0016] at least one sensor functionally connected to the at least one sensor port, wherein the at least one sensor configured to continuously monitor the contents of the feeding solution or the contents of fluids added or drained from the feeding solution,

[0017] wherein each measurement performed by the at least one sensor is transferred to at least one of the server and the hydroponic device; and

[0018] wherein the data bank is a dynamic data bank comprising data from water facilities worldwide, measurements of the feeding solution collected by the at least one sensor, values related to the contents of the feeding solution uploaded by a user uploaded by a user, values related to the location and whether of the feeding solution and values associating the contents of a feeding solution to plant strain or type.

[0019] In some embodiments, the server comprises at least one machine learning algorithm configured to predict changes in the contents of the feeding solution, based on the values stored in the data bank.

[0020] In some embodiments, the hydroponic device is a hub, and wherein the at least one sensor is configured to be dipped in the feeding solution, and monitor the contents of the feeding solution.

[0021] In some embodiments, the system comprises at least one additional module connected to the hub, and obtaining electrical power therefrom, wherein the at least one additional module comprises a microprocessor, and a communication unit, and wherein the at least one additional module is connected to at least one pump and at least one container containing a solution required for adjusting the contents of the feeding solution.

[0022] In some embodiments, the server and/or the hydroponic device include an algorithm continuously updating the system and the components thereof of the water level. The updates are based on initially data corresponding to the dimensions of the container, the volume of the feeding solution, the level (height) of the feeding solution in the container, the surface of the feeding solution, the type/strain of the plant grown in the feeding solution, the age of the plant, the size of the plant, the plant density as well as the weather, season, humidity and wind regime. Based on this information the server and/or the hydroponic device predicts rates of evaporation and consumption by the plants and continuously updates the dimensions of the feeding solution.

[0023] In some embodiments, the at least one additional module is a pH module and the at least one sensor is a pH sensor, and wherein the pH module comprises a communication unit, configured to enable communication between the pH module and at least one of the hub and the server, at least one pump configured to pump an acidic or alkaline solution to the feeding solution, wherein the operation of the at least one pump is controlled by the hub and/or the server.

[0024] In some embodiments, the pH module is fluidly connected to a plurality of containers, at least one container comprising an acidic solution and at least one container comprises an alkaline solution.

[0025] In some embodiments, the pH module comprises a plurality of pumps, wherein at least one pump is fluidly connected to the at least one container comprising the acidic solution and at least one pump is fluidly connected to the at least one container comprises the alkaline solution.

[0026] In some embodiments, the at least one additional module is a nutrient module and the at least one sensor is a nutrient sensor, and wherein the nutrient module comprises a communication unit, configured to enable communication between the nutrient module and at least one of the hub and the server, at least one pump configured to pump a solution of nutrients to the feeding solution, wherein the operation of the pump is controlled by the hub and/or the server.

[0027] In some embodiments, the nutrient module is fluidly connected to at least one container comprising the solution of nutrients.

[0028] In some embodiments, the nutrients module comprises at least one pump fluidly connected to the at least one container comprising the solution of nutrients.

[0029] In some embodiments, the nutrient sensor is an EC sensor.

[0030] In some embodiments, the nutrient sensor is a visualization unit comprising a camera or a video camera.

[0031] In some embodiments, the hydroponic device further comprises a user interface, configured to enable a user to perform one or more of: review the performance of the hydroponic device or any module connected thereto, add new commands, algorithms and software to the hydroponic device and to any of the module connected thereto, and correct errors in the operation of the hydroponic device and any of the modules connected thereto. Each possibility is a separate embodiment of the present invention.

[0032] In some embodiments, the system is further configured to adjust the feeding solution to a required feeding solution contents, by activating pumps associated with one or more of the at least one additional module.

[0033] In some embodiments, the hydroponic device is a reservoir management module, and wherein the at least one sensor port is configured to functionally connect to at least one fluid level sensor adapted to measure the fluid level of the feeding solution.

[0034] In some embodiments, the reservoir management module is fluidly connected to a plurality of conduits and corresponding valves, at least one conduit is configured to allow flow of a predetermined volume of water from a water source to the feeding solution, wherein the flow of water is controlled by a corresponding valve, and at least one conduit is configured to allow draining a predetermined volume of feeding solution, wherein the flow of draining is controlled by a corresponding valve, and wherein the predetermined volume is determined by the at least one microprocessor or by the micro-controller.

[0035] In some embodiments, each measurement performed by the at least one fluid level sensor is stored in an internal storage of the reservoir management module and stored in the server and transferred to the server,

[0036] In some embodiments, the water is tap water or RO water.

[0037] In some embodiments, the flow and/or draining are enabled by gravity, once the valves controlling same, are open.

[0038] In some embodiments, the reservoir management module is further connected to at least one pump fluidly connected to at least one conduit of the plurality of conduits.

[0039] In some embodiments, the reservoir management module is fluidly connected to at least 3 conduits and corresponding valves, at least one conduit is configured to allow flow of a predetermined volume of water from a water source to the feeding solution, at least one conduit is configured to allow flow of a predetermined volume of RO water from an RO water source and at least one conduit is configured to allow draining a predetermined volume of feeding solution.

[0040] In some embodiments, the reservoir management module further comprises at least one sensor configured to measure a level of at least one component in the fluids flowing in at least one of the plurality of conduits.

[0041] In some embodiments, the at least one sensor is configured to measure the level of the at least one component in the fluids when the corresponding valve is locked, thereby enabling measurement prior to flowing into the feeding solution or prior to being drained outside the system.

[0042] In some embodiments, the at least one sensor is selected from a pH sensor, a temperature sensor, an EC sensor, a nutrient sensor, oxidation-reduction potential sensor, minerals sensor and total dissolved solids sensor.

[0043] In some embodiments, there is provided a computer-implemented method for monitoring the level of components associated with plant growth, the method comprising the steps of:

[0044] (a) providing the system disclosed herein and a soil-less system comprising plants grown in a reservoir comprising a feeding solution;

[0045] (b) measuring, a plurality of times, the level of at least one component associated with plant growth;

[0046] (c) identifying a change in the at least one component, between an early measurement to at least one later measurement;

[0047] (d) determining that the identified change requires adjusting the contents of the feeding solution, wherein said identifying and determining is carried out by at least one of the server and the hydroponic device and comprises applying database interrogation on the at least one later measurement with respect to the data bank.

[0048] In some embodiments, the method further comprising repeating steps (b) to (d) periodically.

[0049] In some embodiments, the change in the at least one component, between an early measurement to at least one later measurement refers to deviation from a predefined level of said at least one component.

[0050] In some embodiments, said measuring is performed with the at least one sensor configured to measure the level of the at least one component associated with plant growth.

[0051] In some embodiments, the at least one component is selected from the group consisting of fluid level, pH, EC, nutrient, oxidation-reduction potential, temperature, minerals and total dissolved solids.

[0052] In some embodiments, the method further comprising adjusting the feeding solution by adding at least one solution comprising a required amount of the at least one component, thereby adjusting the feeding solution to include the predefined level of said at least one component (which is at the time of adjustment also referred to as 'the current feeding solution'), wherein the volume of the added solution, the time intervals between consecutive adding and the amount of the at least one component included therein are determined by at least one of the server and the hydroponic device.

[0053] In some embodiments, said adding to the feeding solution comprising transferring from one or more containers fluids that form the added solution.

[0054] In some embodiments, said adding comprises pumping through conduits fluidly connected to at least one pump.

[0055] In some embodiments, the method further comprising adjusting the feeding solution by draining a predetermined volume of feeding solution, wherein the volume of the drained feeding solution and the time intervals between consecutive draining are determined by at least one of the server and the hydroponic device.

[0056] In some embodiments, said continuously comprises a plurality of time per second.

In some embodiments, a computer-implemented method for soilless plant growing is presented. The method comprising:

[0057] monitoring, one or more growth parameters related to growth of the plant and one or more environmental parameters;

[0058] comparing the one or more growth parameters and environmental parameters to an optimal growth profile of the plant, wherein the optimal growth profile is generated by machine learning algorithms trained on a plurality of growth profiles of a plurality of soilless plants;

[0059] identifying a change from the optimal growth profile;

[0060] receiving dynamic financial parameters relating to a cost of the plant growth and market price for the plant or a product producible by/from the plant;

[0061] generating a prediction score based on the one or more monitored growth and environmental parameters and the dynamic financial parameters; and

[0062] outputting, based on the generated prediction score, a recommendation to discontinue growing of the plant if the prediction score is below a predefined threshold; or

[0063] if the prediction score is at or above the predefined threshold, outputting one or more modifications in the one or more growth and/or environmental parameters to adjust the growth profile of the soilless plant to the optimal growth profile.

[0064] In some embodiments, the optimal growth profile is generated by the ML algorithms based on data from a data bank, which is a dynamic data bank comprising data from water facilities worldwide, a plurality of measurements of growth parameters of a plurality of soilless plants, a plurality of measurements of environmental parameters of the plurality of soilless plants and measurements associating water consumption to plant strain or type with different environmental parameters.

[0065] In some embodiments, the plurality of growth profile of the plurality of soilless plants comprise a growth profile as a function of water consumption.

[0066] In some embodiments, the prediction score is generated using a prediction function.

[0067] In some embodiments, the prediction function is generated by Machine Learning (ML) algorithms.

[0068] In some embodiments, the ML algorithms are trained on a plurality of growth and respective environmental parameters derived from a plurality of plant growth cycles in a plurality of plant samples and financial parameters.

[0069] In some embodiments, the one or more growth parameters comprise: height of the plant, weight of the plant/product, number or area of leaves of the plant, mineral content of the plant/product, sugar content of the plant/product, color of the plant/product, water consumption rate of the plant, number of flowers of the plant, number of fruits of the plant or any combination thereof.

[0070] In some embodiments, the one or more environmental parameters comprise: water pH, nutrient level in the water, temperature, humidity, light conditions, or any combination thereof.

[0071] In some embodiments, the dynamic financial parameters comprise: electricity cost, water cost, manpower cost, nutrients cost, or any combination thereof.

[0072] In some embodiments, the product producible by/from the plant comprise: fruits, roots, leaves, or any combination thereof.

[0073] According to some embodiments, a computerized method for automatically providing an optimal growth protocol of a soilless plant is presented herein. The method comprises:

[0074] (a) defining a plant growth optimal outcome (success criterion);

[0075] (b) providing an initial plant growth outcome and an initial corresponding growth protocol obtained from an initial experiment;

[0076] (c) applying the initial plant growth outcome and the corresponding initial growth protocol to ML algorithms, trained on a plurality of plant growth outcomes and corresponding growth protocols;

[0077] (d) outputting a modified growth protocol by the ML algorithms, wherein the first growth protocol comprises a plurality of modifications compared to the initial growth protocol;

[0078] (e) obtaining a resulted plant growth outcome of a plant grown according to the first growth protocol; and

[0079] if the resulted plant growth outcome is inferior to the defined plant growth optimal outcome, repeating steps (c) (by applying the resulted plant growth outcome and the corresponding modified growth protocol to ML algorithms)-(e) until the resulted plant growth outcome is equal to or exceeds the defined plant growth optimal outcome.

[0080] In some embodiments, the growth protocol comprises the growth conditions of the plant and timing and duration for each condition, for example: amounts of nutrients, number of times to add nutrients, times for adding nutrients, pH level, amount of water, light conditions, weather conditions, humidity conditions and the like.

[0081] Certain embodiments of the present disclosure may include some, all, or none of the above advantages. One or more other technical advantages may be readily apparent to those skilled in the art from the figures, descriptions, and claims included herein. Moreover, while specific advantages have been enumerated above, various embodiments may include all, some, or none of the enumerated advantages.

[0082] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure pertains. In case of conflict, the patent specification, including definitions, governs. As used herein, the indefinite articles "a" and "an" mean "at least one" or "one or more" unless the context clearly dictates otherwise.

[0083] Unless specifically stated otherwise, as apparent from the disclosure, it is appreciated that, according to some embodiments, terms such as "processing", "computing", "calculating", "determining", "estimating", "assessing", "gauging" or the like, may refer to the action and/or processes of a computer or computing system, or similar electronic computing device, that manipulate and/or transform data, represented as physical (e.g. electronic) quantities within the computing system's registers and/or memories, into other data similarly represented as physical quantities within the computing system's memories, registers or other such information storage, transmission or display devices.

[0084] Embodiments of the present disclosure may include apparatuses for performing the operations herein. The apparatuses may be specially constructed for the desired purposes or may include a general-purpose computer(s) selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a computer readable storage medium, such as, but not limited to, any type of disk including floppy disks, optical disks, CD-ROMs, magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs), electrically programmable read-only memories (EPROMs), electrically erasable and programmable read only memories (EEPROMs), magnetic or optical cards, or any other type of media suitable for storing electronic instructions, and capable of being coupled to a computer system bus.

[0085] The processes and displays presented herein are not inherently related to any particular computer or other apparatus. Various general-purpose systems may be used with programs in accordance with the teachings herein, or it may prove convenient to construct a more specialized apparatus to perform the desired method(s). The desired structure(s) for a variety of these systems appear from the description below. In addition, embodiments of the present disclosure are not described with reference to any particular programming language. It will be appreciated that a variety of programming languages may be used to implement the teachings of the present disclosure as described herein.

[0086] Aspects of the disclosure may be described in the general context of computer-executable instructions, such as program modules, being executed by a computer. Generally, program modules include routines, programs, objects, components, data structures, and so forth, which perform particular tasks or implement particular abstract data types. Disclosed embodiments may also be practiced in distributed computing environments where tasks are performed by remote processing devices that are linked through a communications network. In a distributed computing environment, program modules may be located in both local and remote computer storage media including memory storage devices.

BRIEF DESCRIPTION OF THE FIGURES

[0087] Some embodiments of the disclosure are described herein with reference to the accompanying figures. The description, together with the figures, makes apparent to a person having ordinary skill in the art how some embodiments may be practiced. The figures are for the purpose of illustrative description and no attempt is made to show structural details of an embodiment in more detail than is necessary for a fundamental understanding of the disclosure. For the sake of clarity, some objects depicted in the figures are not to scale.

[0088] In the Figures:

[0089] FIGS. **1**A and **1**B schematically describes the main principles of known soilless systems;

[0090] FIG. **2** schematically illustrates a soil-less system, according to some embodiments;

[0091] FIGS. **3**A and **3**B schematically illustrates front and perspective views, respectively, of a hydroponic hub, according to some embodiments;

[0092] FIG. **4** schematically illustrates an exploded perspective view of a hydroponic hub, according to some embodiments;

[0093] FIG. **5** presents a block diagram of some components of a hydroponic hub, according to some embodiments;

[0094] FIGS. **6**A and **6**B schematically illustrate front and perspective views of a pH module, according to some embodiments;

[0095] FIG. **7** schematically illustrates an exploded perspective views of a pH module, according to some embodiments;

[0096] FIG. **8** presents a block diagram of a pH module, according to some embodiments;

[0097] FIGS. **9**A and **9**B schematically illustrate front and perspective views of a nutrients module, according to some embodiments;

[0098] FIG. **10** schematically illustrate a reservoir management module, according to some embodiments;

[0099] FIG. **11** presents a block diagram of a reservoir management module, according to some embodiments;

[0100] FIG. **12** presents a flowchart of a method for tracking the contents of a feeding solution and replenishing it, according to some embodiments;

[0101] FIG. **13** presents a flowchart of a method for tracking the contents of a feeding solution and draining it, according to some embodiments; and

[0102] FIG. **14** schematically shows a flow chart of a computer-implemented method for optimizing soilless plant growing, according to some embodiments.

DETAILED DESCRIPTION OF THE INVENTION

[0103] The principles, uses and implementations of the teachings herein may be better understood with reference to the accompanying description and figures. Upon perusal of the description and figures present herein, one skilled in the art will be able to implement the teachings herein without undue effort or experimentation. In the figures, same reference numerals refer to same parts throughout. In the figures, same reference numerals refer to same parts throughout.

[0104] In the description and claims of the application, the words "include" and "have", and forms thereof, are not limited to members in a list with which the words may be associated.

[0105] According to some embodiments, the terms "plant", "soilless plant" and "soil-less plant" may be used interchangeably and refer to a soilless plant.

[0106] Provided herein is a system and uses thereof for hydroponic gardening, configured to continuously monitor and adjust pH and nutrients level of plants soil-less growing media.

[0107] Plant feeding is an important and necessary step for normal plant growth and development. In plants grown in soil-less (such as hydroponics) conditions, the management of plant nutrition is even more important because without the added nutrients the plant may not receive all the minerals and micro-elements required for its growth, productivity and normal development.

[0108] The feeding solution in soilless systems is typically adjusted to the desired features (pH, nutrients etc.) manually using EC (ppm or ms/cm) and pH measurements and obtaining estimated values, based on comparison to generic fertilizer charts. Those charts contain non-specific dose formulas that are not based on the actual conditions of the system, such as, the environment (location, weather), chemical profile of the water that is used for making the feeding solution, the growth stage of the plant, the strain of the plant, among other important parameters. Fertilizing the plant according to the generic feeding charts, typically lead to malnutrition and waste of resources (water, fertilizers etc.)

[0109] Standard fertilization of hydroponics is usually done with fertilizers that are unique for hydroponics wherein their most prominent feature is solubility in water. There is a range of hydroponic fertilizers, with specific formulations to the various growth stages of a plant. Each fertilization solution includes a combination of minerals and micro-elements required for a plant at a certain stage of growth.

[0110] Water naturally contains salts like sodium, calcium, magnesium, bicarbonates, chlorides and sulfates in different doses, the contents of which differ from area to area on the globe. For example, total salt concentration (TDS) in drinking water (typically used for the feed solution) ranges between 0.3-2.0 ms. The presence of salts affects the electrical conductivity (EC) of water and its pH. Hence, EC measurements are typically utilized for monitoring salts contents in hydroponic growth. EC level corresponds to the overall concentration of salts dissolved in the water-the more salts are dissolved, the higher the electrical conductivity.

[0111] Excessive levels of nutrients in the water can cause an osmotic shock in the plant tissue, and may lead to ionic toxicity or nutritional imbalance. Low levels of these nutrients lead to nutritional deficiencies with side effects that can harm the development of the plant.

[0112] The main types of currently used hydroponic systems are NFT and DWC, schematically described in FIGS. **1**A and **1**B, respectively. Such system include a main reservoir **10** encompassing feeding solution **13**, wherein the plant roots are immersed in a flow of feeding solution **13** flowing in a secondary channel or reservoir, that obtains the fluids from reservoir **10** (FIG. **1**A) or the roots are immersed in feeding solution **13** within reservoir **10** (FIG. **1**B). In order to avoid high concentrations of salts in the feeding solution it is customary to rinse the plant substrate and/or replace the feeding solution with a fresh solution, thereby leading to great waste of resources.

[0113] Another disadvantage of the existing techniques is that they rely on generic charts and EC measurements for assessing the concentration of fertilizers and nutrients in the water. This may lead to malnutrition, toxification and other damages. For example, the value of the measured soluble salts concentration in the feeding solution may be normal, yet, the solution is devoid of some specific elements that are essential for plant development which cannot be assessed by simple analysis of EC measurement.

[0114] Another drawback of existing hydroponic system is the approach used for calibration of EC. EC is commonly calibrated by dipping an EC sensor in a single calibration solution and resetting the sensor. Any measured EC value is registered and stored locally on the computer, and if the EC sensor is reset between one measurement to another, it must be calibrated again. Moreover, a single calibration step is usually not accurate and may cause deviations, particularly in measurements at low conductivity ranges. Furthermore, it is necessary to calibrate the EC sensor periodically, every few weeks, while at least the majority of the systems known to date do not have mechanism to monitor the quality of calibration and/or produce periodic alerts. Hence, non-calibrated sensors are widely used, producing erroneous measurements, leading to poor treatment of hydroponic plants.

[0115] pH calibration suffers from similar disadvantages. In hydroponic system pH is usually calibrated by dipping a pH sensor in pH 4 and 7 solutions. If the pH sensor is reset between one measurement to another, it must be calibrated again, where in most systems there are no periodic warnings or alerts to do so.

[0116] It should be noted having suitable pH levels in the root environment, i.e. in the feeding solution, allows the plant to absorb more minerals during all growth stages. Hence, maintaining the required pH, requires continuous balancing the acidity of the feeding solution water to prevent

plant deficiencies. The process of pH adjustment is presently performed in two main ways:

[0117] 1. Manual balance—manually measuring adding base/acid liquid, when required. Manual balancing is time consuming and is inaccurate as the pH level changes at any given moment. Thus, manual adjustment often results in an overshoot phenomenon where the user added acid/base solution in excess.

[0118] 2. Balancing using an acid controller—this approach utilizes external acid and alkali solution tanks, and a target pH level set by a user often taken from public forums and not from studies relevant to a given location, its water profile, weather etc. As the reference value is usually inaccurate, an overshoot of pH typically occurs by adding irrelevant amounts of acid/base solutions.

[0119] As detailed herein, the system and methods disclosed herein enable monitoring various parameters, collecting and storing the data for further analysis, and in parallel, adjusting the parameters continuously, to maintain optimal growth conditions. Moreover, the system disclosed herein includes a database containing information obtained from numerous national (federal) reports on water contents (minerals, nutrients) worldwide, over years and their corresponding EC values, and applies database interrogation, thereby obtaining an accurate profile of any water sample measured by the system.

[0120] Some of the complicated analysis provided by the systems and methods disclosed herein, in accordance with some embodiments, include:

[0121] 1. Dynamic plant feeding technology based on tap water EC/minerals concentration (ppm) analysis. The dynamic plant feeding technology, disclosed herein, enables to calculate the amount of nutrients needed to add to a feeding solution due to changes in the total EC/ppm of the feeding solution. The technology utilizes an algorithm configured to control the measurement of minerals, EC and other components and feature of a feeding solution, and then calculate the amount and/or concentration of a mineral and/or chemical element needed to add to a feeding solution, while aggregating real time measurements of (i) the current amount and/or concentration of a mineral and/or chemical element and/or the EC level inside the feeding solution water tank, (ii) the amount of new water added and/or replaced and/or consumed and/or evaporated and/or removed, (iii) the amount and/or concentration of a mineral and/or chemical element new fluid and/or water added.

[0122] 2. Feeding solution replacement/partial replacement technology and algorithm—The Feeding solution replacement/partial replacement algorithm, disclosed herein, in accordance with some embodiments, is configured to calculate the amount of water needed to add and/or remove and/or replace in the feeding solution. The algorithm is configured to measure and calculate the amount and/or concentration of a mineral and/or chemical element needed to add to a feeding solution as a function of time while aggregating real time measurements of the current amount and/or concentration of a mineral and/or chemical element inside the feeding solution water tank, the EC level of the feeding solution, the amount of new water added and/or replaced and/or consumed and/or evaporated and/or removed, the amount and/or concentration of a mineral and/or chemical element, new fluid, and/or water added.

[0123] 3. Intelligent pH modeling and control algorithm for soils/hydroponics methods:

[0124] a. Dynamic PH balance/adjustment algorithm—the Dynamic pH balance algorithm, disclosed herein, is configured to calculate and trigger the injection of the exact amount of pH increasing/reducing substances to the feeding solution in order to maintain the desired pH level of the solution, it calculates several critical chemical and physical parameters such as the amount of water inside the solution, the chemical composition of the feeding solution, the chemical composition of the pH increasing/reducing balance fluids, and the current and target pH level.

[0125] b. Feeding solution pH changes modeling algorithm—the Feeding solution pH changes modeling algorithm, disclosed herein, in accordance with some embodiments, is configured to monitor and analyze the changes and/or changes' gradient of pH level as a function of time and creates a unique mathematical changes patterns profile. The changes in pH as a function of time can indicate the presence of hostile elements inside the feeding solutions that could harm the plant. The changes in pH as a function of time can also indicate consumption of certain minerals by the plants' roots.

[0126] c. Flexible pH level balance algorithm for optimal plants feeding minerals absorption. For most commonly grown hydroponic crops, an optimal pH range is between 5.5 to 6.5. The optimal acidic pH range for hydroponic crops is important as it affects the solubility, availability and uptake of several of the essential plant nutrients. If the pH drifts too high (past 7), plant uptake of some nutrients becomes less efficient. For example, plants can become iron deficient, even if sufficient iron is present in the nutrient solution. Inexperienced growers may misinterpret these nutrient deficiency symptoms as a problem with the nutrient formulation or product itself, rather than an issue with pH rising above optimal levels for iron and calcium uptake. The Flexible pH level balance algorithm for optimal plants feeding minerals absorption changes the pH level of the feeding solution at a variant time interval in order to allow the absorption of an individual and/or a group of element by the plants roots, therefore, it reduces nutrients deficiencies causes by the pH level of the water.

[0127] The Intelligent pH modeling and control algorithm for soils/hydroponics systems and systems utilizing this algorithm, disclosed herein, have the following advantages (among other advantages):

[0128] The Dynamic PH balance algorithm analyses the feeding solution chemical and physical parameters; this allows precise control over the pH level of the water—without exceeding the target pH range while injecting the optimal amount of pH increasing/reducing balance fluids.

[0129] Canceling (or at least reducing) the pH overshooting effect.

[0130] Creating plant feeding profile according to the changes in pH over time.

[0131] Creating plant diseases and pesticides profile(s) according to the changes in pH over time.

[0132] Flexible pH level control offers absorption of different elements by the plant roots without adding more nutrients to the feeding solution.

[0133] Reducing the nutrients' consumption and waste.

[0134] 4. A computerized method for automatically providing an optimal growth protocol of a soilless plant. The method provides optimal growing protocols. The method is based on machine learning and AI algorithms, trained on a plurality of plant growth outcomes and corresponding growth protocols. The ML algorithms receive a plant growth optimal outcome (success criterion) definition and an initial plant growth outcome with an initial corresponding growth protocol obtained from an initial experiment and output a modified growth protocol wherein the first growth protocol comprises a plurality of modifications compared to the initial growth protocol. The resulted plant growth outcome of a plant grown according to the first growth protocol is feeded into the ML algorithms and if the resulted plant growth outcome is not optimal according to the defined success criterion the process is repeated by applying the resulted plant growth outcome and the corresponding modified growth protocol to the ML algorithms until the resulted plant growth outcome is optimal according to the success criterion.

[0135] 5. A computer-implemented method for optimized soilless plant growing, comparing parameters of plant growth and of environmental conditions to parameters of an optimal growth profile of the soilless plant. The method, according to some embodiments, identifies if there is a change from the parameters of optimal growth profile which indicates a problem in the growth of the plant. The algorithm receives data from the system which monitors during growth cycle of the plant, one or more growth parameters related to growth of the plant and one or more environmental parameters and receives dynamic financial parameters relating to a cost of the plant growth and market price for the plant or a product producible by/from the plant. The algorithm generates a prediction score based on the one or more monitored growth and environmental parameters and the dynamic financial parameters, and outputs, based on the generated prediction score, a recommendation whether to discontinue growing the plant or provide one or more modifications in the growth or environmental parameters to overcome the problem and adjust the growth of the plant to the optimal growth profile.

[0136] In some embodiments, provided herein, are methods and systems for wireless water sensor calibration, for example:

[0137] i. Cloud based water pH sensor calibration and notification algorithm;

[0138] ii. Cloud based water EC/minerals concentration (ppm) sensor calibration.

[0139] In some embodiments, provided herein, are methods for intelligent pH modeling and control algorithm for soil-less/hydroponic growing which include:

[0140] i. Dynamic feeding solution PH balance algorithm, methods and systems using same;

[0141] ii. Feeding solution pH changes modeling algorithm, methods and systems using same; and

[0142] iii. Flexible pH level balance algorithm for optimal plants feeding minerals absorption, methods and systems using same.

[0143] The terms "soilless", "soil-less" and "hydroponic" as used herein are interchangeable, and generally refer to plant growing media which is devoid of soil. The plant growing media may be solid, semi-solid and in the form of solution, preferably, aqueous solution.

[0144] Reference is now made to FIG. **2**, which schematically illustrates, in accordance with some embodiments, a reservoir **10** comprising feeding solution **13**, air pumping unit **15**, liquid pumping unit **16**, a sensor **23** (e.g. a temperature sensor) optionally, pH adjusting solution stored in container **26** and/or at least one nutrients solution stored in at least one container **27** and further comprising system **100** comprising hydroponic hub **22** and/or reservoir management module **28**, and, optionally, any one or more of pH module **24** and nutrients module **25**.

[0145] In some embodiments, system **100** comprises a hydroponic device and server **21**.

[0146] In some embodiments, the hydroponic device is hydroponic hub **22** (also termed hub **22**).

[0147] In some embodiments, the hydroponic device is reservoir management module **28**.

[0148] System **100** is configured for being installed indoors or outdoors, and operate in a hydroponics growing environment, preferably, equipped with wireless connection facilities **17**. The wireless connection may be by way of WiFi, Bluetooth or any other suitable wireless connection. The wireless connection may have access to the internet via any suitable wired or wireless network including any local area network, wide area network, Internet network, telecommunications network, 3G/4G, Wi-Fi enabled network, or Bluetooth enabled network. Each possibility is a separate embodiment of the present invention.

[0149] The wireless connection of system **100** is configured to communicate with a user, for example, through, a user device, such as, personal computer **20**, smartphone **18** or the like (e.g. tablet **19**). In some embodiments, system **100** further comprises server **21**, wherein server **21** comprises, or associate with, storage, storage system, a data bank, operating system and processing system.

[0150] In some embodiments, the data bank comprises data collected from numerous water facilities and authorities, worldwide, reflecting the contents of water samples derived from water sources, over years, the corresponding pH, fertilizer/mineral profile and EC for each water sample. In some embodiments, the data bank is a dynamic data bank continuously enriched with values collected by the sensors of system **100** and values inserted to system **100** by users. In some embodiments, the data bank further comprises values of optimal soilless feeding solutions contents and temperature for a variety of environments, water and plants.

[0151] In some embodiments, the data acquired by the sensors of system **100** and/or by users thereof, is stored in server **21**. Hence, server **21** is configured to store data acquired, and provided by, system **100**.

[0152] In some embodiments, server **21** is within a cloud-based computing environment. In some embodiments, server **21** is tangible, namely, a physical device or component in a computing system that receives and retains information from system **100** or from a user of the system. The server may be internal to a computing device, such as a

computer's hard drive, or a removable device, such as, an external hard drive or universal serial bus (USB) flash drive.

[0153] In some embodiments, server **21** comprises at least one machine learning algorithm configured to predict changes in the contents of the feeding solution, based on the values stored in the data bank. In some embodiments, server **21** is configured to continuously adjust, in real time, the contents of the feeding solution based on predictions performed by the at least one machine learning algorithm, by operating one or more modules connected to system **100**. In some embodiments, wireless communication of system **100** is between hub **22**, server **21** and personal device(s) of the user (e.g. smartphone, iPad or PC) and/or between hub **22** and server **21**, as detailed below.

[0154] In some embodiments, system **100** further comprises reservoir management module **28** fluidly connected to reservoir **10** through valves **11**, **12**, **14**, as detailed below with reference to FIG. **11**.

[0155] In some embodiments, system **100** further comprises at least one of pH module **24** and nutrient module **25**.

[0156] Reference is now made to FIGS. **3**A, **3**B, **4** and **5** which schematically illustrate, in accordance with some embodiments, hub **22**. Hub **22** comprises a circuit board **41**. In some embodiments, circuit board **41** is a microprocessor chip. In some embodiments, circuit board **41** comprises a micro-controller. In some embodiments, hub **22** comprises a communication unit **34**. In some embodiments, circuit board **41** communicates with communication unit **34**. Alternatively, communication between hub **22** and/or circuit board **41** and other components of system **100** is afforded by communication unit **34**.

[0157] Communication between hub **22** and communication unit **34** is required for various activities, including, but not limited to, transfer of data collected by hub **22** to storage, such as, server **21**, through communication unit **34**, collection and transfer of data from one or more sensors connected to hub **22** to server **21**, collection a transfer of data from one or more modules connected to hub **22** to server **21**, for further analysis and processing of data, and the like.

[0158] In some embodiments, communication unit **34** is a wireless communication unit. In some embodiments, communication unit **34** comprises a plurality of wireless communication units. In some embodiments, the wireless communication unit comprises wireless communication circuitry compatible with one or more wireless communication protocols, such as Wi-Fi, ZigBee, Bluetooth and wireless local area network (LAN). Each possibility is a separate embodiment of the present invention. In some embodiments, communication unit **34** is an Ethernet port configure to connect the hub **22**, through a cable, to a network.

[0159] In some embodiments, hub **22** comprises control switch **35** also termed on/off switch, configured to turn on/off hub **22**, or the activity of hub **22**. In some embodiments, control switch **35** is functionally connected to power port **37** wherein hub **22** is connected to electricity or to a power supply through power port **37**. In some embodiments, the power supply comprises one or more batteries. In some embodiments, the power supply is a solar power supply.

[0160] The term "functionally connected to" is synonymous to the term "functionally associated with" and includes indirect connection between two or more elements, e.g. via one or more other elements, non-physical connection between two or more element, e.g. through wireless communication, and also include physical connection between two or more elements.

[0161] In some embodiments, control switch **35** is functionally associated with circuit board **41**. In some embodiments, control switch **35** is functionally associated with a switch control component functionally associated with circuit board **41**. In some embodiments, control switch **35** is configured to initiate the activity of hub **22**. In some embodiments, control switch **35** is configured to reset hub **22**. Resetting hub **22**, may be required under various circumstances, such as, loss of wireless communication and electricity failure. The term "reset" in the context of control switch **35** is exchangeable with the term restart.

[0162] In some embodiments, hub **22** comprises a least one power switch **32**, configured to connect/disconnect additional module(s) to hub **22**, such as, pH module **24** and nutrients module **25**. Power switch **32** is configured to supply power (electricity) to the additional module connected to hub **22**.

[0163] In some embodiments, hub **22** comprises hub front cover **30**, hub back cover **43** and gasket **42**, wherein gasket **42** fills the space between hub front cover **30** and hub back cover **43** when they attach to one another in order to house (hold together) all the component of hub **22**. In some embodiments, hub front cover **30**, hub back cover **43** and gasket **42**, form a sealed structure.

[0164] A "sealed structure" as used herein generally indicates that front and back covers of any of the modules and components describe herein, optionally with a gasket, when joined together prevent anything from passing between them, thus protecting, at least partially, the components within the sealed cover from exposure to humidity and smoke, among others.

[0165] In some embodiments, hub back cover **43** comprise screw ports configured to enable mounting hub **22** onto a solid surface, e.g. a wall, using screws, such as, screws **44**.

[0166] In some embodiments, hub **22** comprises indicator **36** configured to provide visual and/or auditory signals under various circumstances, based on signal/instructions received from circuit board **41**. In some embodiments, indicator **36** receives instructions/signal from an indicator control component, located within, or functionally associated with, circuit board **41**. For example, indicator **36** may provide blinking red light when one of the sensors, e.g. the pH or the ORP sensors detect a suboptimal value. More generally, indicator **36** may be used for producing visual and/or auditory signals in response to one or more status codes or error codes, including, but not limited to, low power of system **100** or components thereof, such as, hub **22**. The signals may be visual signals, blinking and/or different colors, where each distinct signal indicates a specific status or error. In some embodiments, indicator **36** comprises LED light source. In some embodiments, indicator **36** is positioned on the front face of hub front cover **30**, thereby a user can easily view or here the indications produced by indicator **36**.

[0167] In some embodiments, hub **22** comprises a plurality of sensors. In some embodiments, hub **22** comprises one or more sensors selected from the group consisting of pH sensor, temperature sensor, EC sensor, oxidation-reduction potential (ORP) sensor, minerals sensor and total dissolved solids (TDS) sensor. Each possibility is a separate embodiment of the present invention.

[0168] Any sensor known in the art can be employed in the context of system **100** for providing the required measurements.

[0169] In some embodiments, the mineral sensor comprises a plurality of sensor each sensor configured to sense at least one compound (e.g. Calcium, ammonium, sodium) or at least one composition of compounds comprising specific compounds at specific concentrations.

[0170] In some embodiments, hub **22** comprises a temperature sensor port **38**, configured to connect to a temperature sensor. In some embodiments, hub **22** comprises a temperature sensor configured to connect to hub **22** through port **38**, and further configured to measure temperature of a feeding solution.

[0171] In some embodiments, the temperature sensor is selected from an RTD (resistance temperature detector), thermometer and thermocouple. Each possibility is a separate embodiment of the present invention.

[0172] In some embodiments, hub **22** further comprises a pH sensor port **39** configured to connect to a pH sensor. In some embodiments, hub **22** comprises a pH sensor configured to connect to hub **22** through port **39**, and further configured to measure the pH of a feeding solution.

[0173] The term "pH sensor" as used herein refers to any sensor configured to measure pH, such as, an electrochemical pH sensor, including, combination electrochemical pH sensors having both a measuring electrode detecting changes in the pH value and a reference electrode which provides a stable signal for comparison.

[0174] In some embodiments, hub **22** may further comprises at least one port selected from oxidation-reduction potential (ORP) port (not shown) configured to functionally connect to at least one ORP sensor, electrical conductivity (EC) port (not shown) configured to functionally connect to at least one EC sensor, total dissolved solids (TDS) port **40** configured to functionally connect to at least one TDS sensor. Each possibility is a separate embodiment of the present invention.

[0175] In some embodiments, hub **22** comprises at least one port selected from an ORP sensor configured to connect to hub **22** through an ORP port, and further configured to measure the ORP of a feeding solution; an EC sensor configured to connect to hub **22** through an EC port, and further configured to measure the EC of a feeding solution; and a TDS sensor configured to connect to hub **22** through TDS port **40**, and further configured to measure the TDS of a feeding solution. Each possibility is a separate embodiment of the present invention.

[0176] In some embodiments, the EC sensor is used as a nutrient sensor. The EC sensor collected EC data which is analyzed by hub **22** based on data stored in storage **21** which includes numerous EC values for water with different types of minerals (nutrients and fertilizers) at various concentrations. The analysis includes (i) selecting the best fit between an EC value measured in a feeding solution and an EC value, or a plurality of values from the data bank stored in storage **21**, (ii) deducing the nutrients contents of the feeding solution corresponding to the measured EC value, (iii) deciding the type of nutrient or nutrient formulation, and the amount or concentration thereof, that has to be added to the feeding solution in order to adjust it to the required/desired nutrient profile; (iv) instructing nutrient module **25** to supplement a feeding solution with said type of nutrient or nutrient formulation and said amount/concentration thereof.

[0177] The term "best fit" as used herein refers to a statistical outcome obtained from comparing a measured parameter, range, or group of parameters (such as, EC value) to a database or a data bank of parameters and their corresponding identity (e.g. a database of EC values of water samples and the corresponding contents of nutrients in each water sample sample), aiming to assign a value, or range, of identities that is/are most similar to the measured parameters. This type of analysis is often referred to as database interrogation and best fit may be synonymous, according to some embodiments, to a high probability score. A high probability score reflects the probability that the measured parameter is having, or closely correlates to, a specific identity. For example, a high probability score reflects that a given measured EC corresponds to a particular water contents, having a specific content of minerals.

[0178] In some embodiments, hub **22** comprises a nutrient sensor comprising a visualization unit, such as a camera, which records the plants dimension, color, leaf texture and other physical/external characteristics of the plant. The data is collected and analyzed by hub **22**, based on which addition of nutrients from container(s) **27** to a feeding solution, is carried out (or not). The analysis includes comparing the data (one or more images, or videos) obtained from the nutrient sensor to data stored in server **21** which includes numerous images and videos of plants at various conditions and the corresponding feeding solution used for the recorded plants. The analysis further includes (i) selecting the best fit between the data measured by the nutrient sensor and an image, a video, a plurality of images, or videos from the data bank stored in sever **21**, (ii) deducing the nutrients contents of the feeding solution corresponding to the data obtained from the nutrient sensor, (iii) deciding the type of nutrient or nutrient formulation, and the amount or concentration thereof, that has to be added to the feeding solution in order to adjust it to the required/desired nutrient profile; (iv) instructing nutrient module **25** to supplement a feeding solution with said type of nutrient or nutrient formulation and said amount/concentration thereof.

[0179] In some embodiments, the camera is a video camera.

[0180] In some embodiments, server **21** comprises at least one image analysis algorithm, and wherein said deducing the nutrients contents of the feeding solution corresponding to the data obtained from the nutrient sensor comprises applying the at least one image analysis algorithm.

[0181] In some embodiments, server **21** is continuously trained by applying the at least one machine learning algorithm (such as, but not limited to, decision trees, boosting, support-vector machines, neural networks, nearest neighbor algorithms, Naive Bayes, bagging, random forests, etc.) to the collected data measured by the nutrient sensor or any other sensor of system **100**.

[0182] In some embodiments, hub **22** comprises a user interface **33** configured to enable a user to review the activities of hub **22**, revise the activities of hub **22**, add activities to hub **22** and detect errors in the operation of hub **22**. In some embodiments, the user is a layman, a software engineer, a programmer, computers' technician, and an engineer. Each possibility is a separate embodiment of the present invention.

[0183] User interface **33** is configure to enable a user, such as a programmer or a software engineer and other user with the required professional and technical skills, but not nec-

essarily, perform at least one of the activities selected from: review the performance of hub **22**, add new commands, algorithms and software to hub **22**, and identify and correct errors in the operation of hub **22**. Each possibility is a separate embodiment of the present invention. Similarly, through user interface **33** the user can review the performance of any module which is connected an controlled by hub **22**, such as, pH module and nutrients module, can manipulate the activities of the other modules and can further identify and correct errors in the operation of the other modules.

[0184] In some embodiments, circuit board **41** of hub **22** comprises an internal storage, or is associated with an internal storage, configured for storage of data collected from the one or more sensors attached to hub **22**. The values measure by the various sensors include parameters and functions required for the activity and operation of hub **22**. In some embodiments, circuit board **41** comprises an algorithm converting measured values collected by the one or more sensors, and stored in the internal storage, to the corresponding parameter (e.g., converting mV values measured by the pH sensor to pH values).

[0185] In some embodiments, hub **22** is configured to transfer the measured values collected by the one or more sensors to server **21** wherein server **21** comprises an algorithm converting the measured values to the corresponding parameter.

[0186] In some embodiments, the internal storage is configured for storage of definitions of the dimensions of container **10** and feeding solution **13** at the initial stage obtained by a user.

[0187] In some embodiments, hub **22** is configured to collect, store and transfer to server **21** the data obtained from the measurements performed by the one or more sensors attached thereto through corresponding ports (temperature, pH, EC, TDS etc.) and from the one or more modules connected thereto, namely, hub **22** is configured to monitor, in real time, various feature related to a feeding solution, when system **100** is connected to reservoir **10** containing feeding solution **13**. Hub **22** is further configured to transmit part or all of the data collected by the sensors connected thereto, to server **21**. In addition, a user may communicate with hub **22** via the internet connected to a personal computer **20**, smartphone **18** or any other appropriate device for reviewing the data collected by the sensors.

[0188] Reference is now made to FIGS. **6**A, **6**B, **7** and **8** which illustrate components of pH module **24**. pH module **24** comprises front cover **30***a*, back cover **43***a*, and gasket **42***a*, wherein gasket **42***a* fills the space between front cover **30***a* and back cover **43***a* when they attach to one another in order to house (hold together) all the component of pH module **24**. In some embodiments, front cover **30***a*, back cover **43***a* and gasket **42***a*, form a sealed structure.

[0189] In some embodiments, back cover **43***a* comprise screw ports configured to enable mounting pH module **24** onto a solid surface, e.g. a wall, using screws, such as, screws **44***a*.

[0190] In accordance with some embodiments, pH module **24** comprises a circuit board **41***a*. In some embodiments, circuit board **41***a* is a microprocessor chip. In some embodiments, circuit board **41***a* comprises, or associates with, pump control circuit board.

[0191] In some embodiments, pH module **24** comprises a communication unit, such as, communication unit **34**. In some embodiments, the communication unit of pH module **24** communicates with hub **22**, and obtains therefrom commands. The commands obtained from hub **22** are directed to release of an acidic or an alkaline solution (collectively termed 'adjusting solution) to a feeding solution, such as feeding solution **13** in reservoir **10**, in order to adjust the pH of the feeding solution to a pH determined by hub **22**.

[0192] In some embodiments, the communication unit of pH module **24** communicates with server **21**, and obtains therefrom commands.

[0193] In some embodiments, the commands obtained from hub **22** and/or from server **21** specify adjustment regimen.

[0194] The term 'adjustment regimen' as used herein refers to the type of adjusting solution, the volume of adjusting solution, the time intervals between subsequent additions of a volume of adjusting solution and combinations thereof. The type of adjusting solution may be in the form of a brand name, pH value, concentration of active agent (e.g. acid, base, nutrient, mineral, fertilizer), pump, pump number, color of container containing the solution, color of solution and any other property that identifies the solution.

[0195] In some embodiments, circuit board **41***a* communicates with the communication unit of pH module **24**. Alternatively, communication between pH module **24** and/or circuit board **41***a* and other components of system **100**, in particular, hub **22** and server **21** is afforded by the communication unit.

[0196] In some embodiments, pH module **24** is associated with at least one pump, also termed hereinafter pH pump, configured to pump acidic/alkaline solution from container (s) **26** to a feeding solution, such as, feeding solution **13** when system **100** is connected thereto.

[0197] The term 'pump' as used herein refers to any type of pump that is suitable for system **100** and its components. Any of the pumps disclosed herein is connected to at least one of pump current sensor and pump control circuit board, which perform at least one of the following activities: monitor the operation of the pump, adjust the operation of the pump, send alert to a user in case the pump operation is damaged, store the amount of liquids pumped in and out by the pump and transfer to hub **22** or server **21** data related to the operation and function of the pump. Each pump includes a motor and a head, connected to conduits/tubes/pipes configured to pump in/out fluids. Accordingly, each pump further associates with valves (such as mechanical or electronic valves) to control the flow of the pumped fluids.

[0198] It is to be understood that system **100** and its components are independent, and not an integral part, of any feeding solution and/or a container comprising a feeding solution. Thus, when stated herein that the components of system **100** measure parameters related to a feeding solution, it is intended to state that such measurements are carried out, or can be carried out, when system **100** is coupled, or associated with, a given feeding solution.

[0199] In some embodiments, pH module **24** comprises at least one pump. It is to be understood that association of pH module **24** with the at least one pH pump, or encompassing at least one pump, means that certain components of the at least one pH pump are housed within pH module **24** and/or are linked to components of pH module **24** which operate (turn on/off) the at least one pH pump. In some embodiments, the at least one pH pump is a peristaltic pump. In

some embodiments, pH module **24** controls the operation of the at least one pH pump. In some embodiments, pH module **24** comprises the motor of the at least one pump. In some embodiments, pH module **24** comprises the eccentric rotor of a peristaltic pump.

[0200] In some embodiments, pH module **24** is associated with a plurality of pH pumps, wherein at least one pH pump is configured to pump acidic solution from container **26***ac* (not shown) to a feeding solution, such as, feeding solution **13**, and at least one pH pump is configured to pump basic solution from container **26***alk* (not shown) to a feeding solution, such as, feeding solution **13**.

[0201] In some embodiments, pH module **24** comprises indicator **36***a* configured to provide visual and/or auditory signals under various circumstances, based on signal/instructions received from circuit board **41***a*. In some embodiments, indicator **36***a* receives instructions/signal from an indicator control component, located within, or functionally associated with, circuit board **41***a*. For example, indicator **36***a* may provide blinking red light when the pH detected by pH sensor is at a suboptimal value. In some embodiments, indicator **36***a* comprises LED light source. In some embodiments, indicator **36***a* is positioned on the front face of hub front cover **30***a*, such that, the indications produced thereby can be viewed or heard.

[0202] In some embodiments, at least one pH pump is an acid pH pump encompassing a tube (not shown) having one end dipped in container **26***ac* and another end close to the surface of feeding solution **13**, wherein pH module **24** controls the operation of said acid pH pump. In some embodiments, the one end of the tube dipped in container **26***ac* is clipped, fixed, passes through, or otherwise held, by acid in-clasp **45** and the other end of the tube dipped in container **26***ac* is clipped, fixed, passes through, or otherwise held, by acid out-clasp **46**.

[0203] It is to be understood that none of the tubes/conduits used for adding fluids to the feeing solution are immersed or dipped inside the feeding solution. The end of such tubes/conduits are in close proximity to the surface of the feeding solution and pour (or drip or the like) the fluids onto the feeding solution.

[0204] In some embodiments, at least one pH pump is a basic (alkaline) pH pump encompassing a tube having one end dipped in container **26***alk* and another end in close proximity to the surface of the feeding solution **13**, wherein pH module **24** controls the operation of said basic pH pump. In some embodiments, the one end of the tube dipped in container **26***alk* is clipped, fixed, passes through, or otherwise held, by alk in-clasp **47** and the other end of the tube dipped in container **26***alk* is clipped, fixed, passes through, or otherwise held, by alk out-clasp **48**.

[0205] The term "tube" as used herein generally refers to any a hollow wire, channel, pipe, duct and the like, capable of transferring fluids. In some embodiments, the tube is flexible and is adjusted to being compressed during operation (pumping) of fluids from containers, e.g. **26**, **26***ac*, **26***alk*, **27**, to the feeding solution. Optionally, each of the tubes disclosed herein is connected to other part of the pump associated therewith, or the system **100** through one or more barb connectors **57**.

[0206] In some embodiments, the at least one pump associated with pH module **24** comprises one or more motors functionally connected to a pump head, wherein the pump or components thereof may be mounted, or otherwise connected, to the at least one pump through one or more mounting elements **55** which may attach the pump, to back cover **43***a*.

[0207] Any motor pumps known in the art may be suitable, including, but not limited to, rachet motor, DC motor, servo motor, step motor.

[0208] In some embodiments, the at least one pump associated with pH module **24** comprises one or more DC motor **54** functionally connected to peristaltic pump head **56**, wherein the pump or components thereof may be mounted, or otherwise connected, to the at least one pump through one or more mounting elements **55** which may attach the pump, to back cover **43***a*. In some embodiments, each DC motor **54** is functionally connected and controlled, and optionally, powered, by circuit board **41***a* of pH module **24**. In some embodiments, each DC motor **54** is functionally connected and controlled, and optionally, powered, by pump control circuit board of pH module **24**.

[0209] In some embodiments, pH module **24** comprises a pump control circuit board, adapted to control the operation of the at least one pump. In some embodiments, the pump control circuit board is activated by circuit board **41***a* of pH module **24**. In some embodiments, the pump control circuit board is activated by circuit board **41** of hub **22**.

[0210] In some embodiments, pH module **24** comprises a pump current sensor adapted to continuously monitor the performance of the at least one pump, detect malfunction (such as, lack or low contents of solution(s) in the container (s), electrical failure, and/or disconnected valves) and accordingly transfer an alert to hub **22** and/or server **22**, which may communicate with the user. The alert details the failure, and may include instructions to the user (e.g. to replace an empty container etc.). Alternatively, the hub **22** and/or server **22** may handle the malfunction. For example, when the malfunction is reduced functionality of a certain pump, may revise the operation of that pump for example, change the pulse-width modulation, and in parallel may induce an alert to a user to replace the problematic pump.

[0211] In some embodiments, the at least one pump is powered by pH module **24** which in turn obtains power from hub **22**. In some embodiments, the at least one pump is connected to a power source and is independently powered,

[0212] In some embodiments, pH module **24** comprises a plurality of power switch **32***a*, wherein at least one power switch **32***a* is configured to connect/disconnect pH module **24** to/from hub **22** and at least another power switch **32***a* is configured to connect pH module **24** to another module, such as, nutrient module **25**.

[0213] In some embodiments, pH module **24** comprises control switch (not shown) also termed on/off switch, configured to turn on/off pH module **24**, or the activity of pH module **24**. In some embodiments, the control switch is functionally associated with circuit board **41***a*. In some embodiments, the control switch is functionally associated with a switch control component functionally associated with circuit board **41***a*.

[0214] In some embodiments, pH module **24** comprises user interface configured to enable a user to review the activities of pH module **24**, revise the activities of pH module **24**, add activities to pH module **24** and detect errors in the operation of pH module **24**. Each possibility is a separate embodiment of the present invention.

[0215] In some embodiments, pH module **24** comprises an internal storage associated with the microprocessor thereof,

configured for storage of data related to the operation of pH module **24**. In some embodiments, the data related to the operation of pH module **24** comprises data acquired by the current sensor, properties of the solution stored in container (s) **26**, amount of the solution stored in container(s) **26** which has been pumped through the at least one pH pump to feeding solution **13**, function of the at least one pH pump.

[0216] In some embodiments, the data acquired by the current sensor comprises current failure. In some embodiments, the current failure data is transmitted to any one or more of hub **22** and server **21** which in turn fix the failure and/or produce an alert to a user.

[0217] Fixing the failure may include resetting pH module **24** and/or restoring connection of pH module **24** to hub **22**, among other procedures.

[0218] In some embodiments, the solution stored in container(s) **26** is an acid solution and the properties of the solution comprise any one or more of volume of the solution stored in container(s) **26**, pH, active agent (e.g. HCl), concentration, manufacturer and brand name. Each possibility is a separate embodiment of the present invention.

[0219] In some embodiments, the solution stored in container(s) **26** is an alkaline solution and the properties of the solution comprise any one or more of pH, active agent (e.g. NaOH), concentration, manufacturer and brand name. Each possibility is a separate embodiment of the present invention.

[0220] In some embodiments, hub **22** is configured to transfer the measured values collected by the one or more sensors to server **21** wherein server **21** comprises an algorithm converting the measured values to the corresponding parameter.

[0221] In some embodiments, the amount of the solution stored in container(s) **26** comprises any one or more of volume, concentration, amount of active agent, and combinations thereof.

[0222] In some embodiments, the internal storage is configured for storage of definitions of the dimensions of container **10** and feeding solution **13** at the initial stage obtained by a user.

[0223] In some embodiments, pH module **24** comprises a current sensor configured to monitor the connection pH module **24** of to the power obtained from hub **22**. In some embodiments, upon loosing connection to power, indicator **36***a* produced an audible or visible signal.

[0224] Reference is now made to FIGS. **9**A, **9**B, which illustrate components of nutrients module **25**.

[0225] The term "nutrient" as used herein is exchangeable with mineral, and refers to additives which improve plants health, growth, yield, resistance to pathogens and the like. Typically, nutrients are supplied to plants by the soil. Such nutrients include, but are not limited to, nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, boron, molybdenum, copper, zinc, chlorine, and cobalt. The nutrient solution disclosed here may contain various nutrients, fertilizers and minerals, as different ratios/quantities. Alternatively, the nutrient solution refers to a plurality of nutrient solutions, each containing one or more nutrients, or mixture of nutrients. The type of nutrient solution, amount, timing and all other parameters related to use of each of the nutrient solution is determined by hub **22** and/or server **21**. Stated otherwise, the 'decision' of nutrient module **25** regarding the addition of nutrients to a feeding solution, is made by hub **22** and/or server **21**.

[0226] In some embodiments, the communication between hub **22** and nutrient module **25** is though the communication unit of hub **22** and the communication unit located within nutrient module **25**. In some embodiments, the communication between server **21** and nutrient module **25** is though a communication unit of server **21** and the communication unit located within nutrient module **25**. The communication between hub **22**, server **21** and nutrient module **25** includes transfer of commands from the former to the latter.

[0227] In some embodiments, the commands obtained from hub **22** and/or from server **21** specify adjustment regimen.

[0228] In some embodiments, nutrient module **25** comprises a current sensor configured to monitor the connection nutrient module **25** of to the power obtained from hub **22**. In some embodiments, upon loosing connection to power, indicator **36***b* produced an audible or visible signal.

[0229] In some embodiments, nutrient module **25** comprises an internal storage associated with the microprocessor thereof, configured for storage of data related to the operation of nutrient module **25**. In some embodiments, the data related to the operation of nutrient module **25** comprises data acquired by a current sensor, data acquired by one or more nutrient sensor connected to corresponding port(s) in hub **22**, properties of the solution stored in container(s) **27**, amount of the solution stored in container(s) **27** which has been pumped through the at least one nutrient pump to feeding solution **13**, function of the at least one nutrient pump.

[0230] In some embodiments, the data acquired by the current sensor comprises current failure. In some embodiments, the current failure data is transmitted to any one or more of hub **22** and server **21** which in turn fix the failure and/or produce an alert to a user.

[0231] Fixing the failure may include resetting nutrient module **25** and/or restoring connection of nutrient module **25** to hub **22**, among other procedures.

[0232] In some embodiments, the properties of the solution stored in container(s) **27** comprise any one or more of nutrient composition, concentration of each nutrient in the nutrient composition, volume of nutrient solution in each of container **27**, manufacturer and brand name. Each possibility is a separate embodiment of the present invention.

[0233] In some embodiments, the internal storage is configured for storage of definitions of the dimensions of container **10** and feeding solution **13** at the initial stage obtained by a user.

[0234] Nitrogen is one of the most essential elements in the vegetative growth stage of the plant, and the addition of nitrogen-rich fertilizers tend to change the pH level in the growth medium. Therefore, in the growth phase it is particularly important to monitor and control the pH level in the growth medium in parallel to monitoring nutrient/fertilizer/mineral levels.

[0235] Nutrient module **25** comprises front cover **30***b*, back cover **43***b*, and optionally, a gasket (not shown), wherein when attached to one another house (hold together) all the component nutrient module **25**. Optionally, the housing formed is sealed.

[0236] In some embodiments, back cover **43***b* comprise screw ports configured to enable mounting nutrient module **25** onto a solid surface, e.g. a wall, using screws.

[0237] In accordance with some embodiments, nutrient module **25** comprises a circuit board (not shown). In some embodiments, the circuit board is a microprocessor chip. In some embodiments, the circuit board comprises, or associates with, nutrient pump control circuit board.

[0238] In some embodiments, the circuit board of nutrient module **25** communicates with the communication unit of nutrient module **25**. Alternatively, communication between nutrient module **25** and/or its circuit board and other components of system **100**, in particular, hub **22** is afforded by the communication unit.

[0239] In some embodiments, the communication unit of nutrient module **25** communicates with hub **22**, and obtains therefrom commands. The commands obtained from hub **22** are directed to release of any one or more of nutrient solution(s) to a feeding solution, such as feeding solution **13** in reservoir **10**, in order to adjust the nutrient profile of the feeding solution to a nutrient profile assigned by hub **22**.

[0240] In some embodiments, nutrient module **25** is associated with at least one pump, also termed hereinafter nutrient pump, configured to pump nutrient solution from container(s) **27** to a feeding solution, such as, feeding solution **13**.

[0241] It is to be understood that association of nutrient module **25** with the at least one nutrient pump means that certain components of the at least one nutrient pump are housed within nutrient module **25** and/or are linked to components of nutrient module **25** which operate (turn on/off) the at least one nutrient pump. In some embodiments, the at least one nutrient pump is a peristaltic pump. In some embodiments, nutrient module **25** controls the operation of the at least one nutrient pump. In some embodiments, nutrient module **25** comprises the motor of the at least one pump. In some embodiments, nutrient module **25** comprises the eccentric rotor of a peristaltic pump.

[0242] In some embodiments, nutrient module **25** is associated with at least one pump configured to pump a nutrient solution from container **27** to a feeding solution, such as, feeding solution **13**. In some embodiments, nutrient module **25** is associated with a plurality of nutrient pumps, each nutrient pump is configured to pump a nutrient solution from one of containers **27** to a feeding solution, such as, feeding solution **13**.

[0243] In some embodiments, nutrient module **25** comprises a pump control circuit board, adapted to control the operation of the at least one pump or at least one pump in the plurality of pumps. In some embodiments, the pump control circuit board is activated by circuit board **41***b* of nutrient module **25**. In some embodiments, the pump control circuit board is activated by circuit board **41** of hub **22**.

[0244] In some embodiments, the at least one pump is powered by pH module **24** which in turn obtains power from hub **22**. In some embodiments, the at least one pump is connected to a power source and is independently powered,

[0245] In some embodiments, nutrient module **25** comprises indicator **36***b* the characteristics and definitions of which are similar to those of indicators **36** and **36***a* and are adjusted to nutrients/fertilizers/minerals, where applicable.

[0246] In some embodiments, each nutrient pump includes a tube having one end dipped in one of containers **27** and another end in close proximity to the surface of the feeding solution **13**, wherein nutrient module **25** controls the operation of said pump. In some embodiments, the one end of the tube dipped in one of containers **27** is clipped, fixed, passes through, or otherwise held, by in-clasp i**61***a*, i**61***b*, i**61***c* or i**61***d* and the other end of the tube is clipped, fixed, passes through, or otherwise held, by the corresponding out-clasp o**61***a*, o**61***b*, o**61***c* or o**61***d*.

[0247] In some embodiments, nutrient module **25** comprises power switch **32***b*, configured to connect/disconnect nutrient module **25** from system **100**, and/or form hub **22**.

[0248] In some embodiments, nutrient module **25** comprises control switch (not shown) also termed on/off switch, configured to turn on/off nutrient module **25**, or the activity of nutrient module **25**. In some embodiments, the control switch is functionally associated with circuit board **41***b*. In some embodiments, the control switch is functionally associated with a switch control component functionally associated with circuit board **41***b*.

[0249] Reference is now made to FIGS. **10** and **11** which schematically illustrate, in accordance with some embodiments, reservoir management module **28**. Reservoir management module **28** controls the addition of water **70**, to a reservoir, such as, reservoir **10**, e.g. via valves **11** and **14** that control the flow of water and RO water, respectively. In some embodiments, said control the addition of water comprises at least one of controlling the type of water (e.g. regular or RO), controlling the amount of water, controlling through which valve the additional water flows. Each possibility is a separate embodiment of the present invention.

[0250] In some embodiments, system **100** further comprises reservoir management module **28**.

[0251] Is some embodiments, system **100** comprises reservoir management module **28** as the main module, and optionally, further comprising additional modules, such as, pH module **24** and/or, nutrient module **25**, and is devoid of hub **22**.

[0252] In some embodiments, reservoir management module **28** comprises an internal storage associated with the microprocessor thereof, configured for storage of data related to the operation of reservoir management module **28**. In some embodiments, the data related to the operation of reservoir management module **28** comprises data acquired by the water level sensor, properties of the feeding solution, amount of fluids transferred through reservoir management module **28** to feeding solution **13**, amount of fluids drained from feeding solution **13** through reservoir management module **28**, function of one or more pumps associated with reservoir management module **28**.

[0253] In some embodiments, the data acquired by the water level sensor indicates change in water level, thereby reservoir management module **28** initiates delivery of a volume of fluids to feeding solution **13** or drainage of a volume of feeding solution **13**, wherein said volume is calculated by the microprocessor of reservoir management module **28**, using data stored in the internal storage, which includes the concentration of the various components of feeding solution **13**.

[0254] In some embodiments, the data acquired by the water level sensor indicates reduced water level. In some embodiments, the data acquired by the water level is transmitted to server **21** which in turn provides to instruction to add a volume of fluids to feeding solution **13**, wherein the instruction further specify the type of fluids, selected from water and RO water.

[0255] In some embodiments, the data acquired by the water level sensor indicates elevated water level. In some embodiments, the data acquired by the water level is trans-

mitted to server **21** which in turn provides to instruction to drain a volume of water to feeding solution **13**.

[0256] In some embodiments, the data acquired by the water level sensor produce an alert to a user. In some embodiments, the alert is a visible or audible alert produced by an indicator of reservoir management module **28**. In some embodiments, the alert is a message sent to a user device.

[0257] In some embodiments, module **28** is fluidly connected to a plurality of conduits **66**, **68** and **70**, and corresponding valves **11**, **12**, **14**, configured to control the flow of fluids (e.g. water, feeding solution) into a feeding solution, such as, feeding solution **13**, in order to achieve a required water level, and/or dilute the contents of the feeding solution in order to achieve the desired pH and/or nutrient profile. The valves are also configured to control drainage of fluids from a reservoir, such as, reservoir **10**, for example, in order to enable supplementation of the reservoir with specific nutrients, and/or in order to increase the concentration of nutrients in the reservoir, among other purposes.

[0258] In some embodiments, the flow of water entering module **28** through conduit **66** to reservoir **10** is allowed when valve **11** is open, wherein opening of valve **11** is controlled by module **28** and is enabled after sensors **60**, **62** and **64** measured the pH, EC and flow rate, respectively, of the water entering through conduit **66** and after the measurements have been recorded in the internal storage of module **28**. Thus, module **28** is configured for controlling the input flow of water from a water source into a reservoir of feeding solution, such as, reservoir **10**.

[0259] In some embodiments, the water is tap water.

[0260] In some embodiments, the flow of reverse osmosis (RO) water entering module **28** through conduit **68** to reservoir **10** is allowed when valve **12** is open, wherein opening of valve **12** is controlled by module **28** and is enabled after sensors **60**, **62** and **64** measured the pH, EC and flow rate, respectively, of the RO water entering through conduit **68** and after the measurements have been recorded in the internal storage of module **28**. Thus, module **28** is configured for controlling the input flow of RO water from a source of RO water into a reservoir of feeding solution, such as, reservoir **10**.

[0261] In some embodiments, reservoir management module **28** controls fluid entrance into reservoir **10** by controlling when to open valves **11** and/or **12** and for how long let any of these valves remain open. In some embodiments, reservoir management module **28** controls the amount of fluid entering reservoir **10** through valves **11** and **12**.

[0262] In some embodiments, the out-flow of excess (drain) water from reservoir **10** through module **28** via conduit **70** is allowed when valve **14** is open, wherein opening of valve **14** is controlled by module **28**. Thus, module **28** is configured for controlling the output flow of drain water from reservoir **10**. Optionally, the sensors **60**, **62** and **64** may measure the pH, EC and flow rate, respectively, of the drain water exiting through conduit **70**.

[0263] In some embodiments, reservoir management module **28** controls fluid draining from reservoir **10** by controlling when to open valve **14** and for how long let valve **14** remain open. In some embodiments, reservoir management module **28** controls the amount of fluid draining from reservoir **10** through valve **14**. In some embodiments, fluid draining comprises draining of a feeding solution, such as, feeding solution **13** from the reservoir containing same, such as, reservoir **10**.

[0264] In some embodiments, module **28** comprises at least one pump configured to enable fluid flow through at least one of conduits **66**, **68** and **70**. In some embodiments, fluid flow through any one or more of conduits **66**, **68** and **70** is induced by at least one pump. In some embodiments, module **28** comprises at least one pump configured to enable water flow from water source through conduits **66** to reservoir **10**. In some embodiments, module **28** comprises at least one pump configured to enable flow of RO water from RO water source through conduits **68** to reservoir **10**. In some embodiments, module **28** comprises at least one pump configured to enable flow of drain feeding solution **13** from reservoir **10** through conduits **70**.

[0265] In some embodiments, reservoir management module **28** comprises a plurality of sensor ports, configured to connect to a plurality of sensors, wherein at least one sensor port is a water level sensor port configured to connect to a water level sensor **29**. In some embodiments, reservoir management module **28** comprises a plurality of water level sensors **29**.

[0266] In some embodiments, water level sensor **29** is a fluid level sensor selected from glass level gauge, floats, hydrostatic measurement device (e.g. bubbler, differential pressure transmitter, displacer), load cell, magnetic level gauge, capacitance transmitter, magnetostrictive level transmitter, ultrasonic level transmitter, later level transmitter and radar level transmitter. Each possibility is a separate embodiment of the present invention.

[0267] In some embodiments, module **28** further comprises one or more sensor ports configured to connect to sensors selected from the group consisting of pH sensor **60**, temperature sensor (not shown), EC sensor **62**, oxidation-reduction potential (ORP) sensor (not shown), minerals sensor (not shown) and total dissolved solids (TDS; not shown). Each possibility is a separate embodiment of the present invention.

[0268] In some embodiments, reservoir management module **28** further comprises a flow rate sensor **64**. In some embodiments, the flow rate sensor is a flowmeter. In some embodiments, the flowmeter is selected from obstruction type, inferential, electromagnetic, positive-displacement, vortex shedding, anemometer, ultrasonic and mass. Each possibility is a separate embodiment of the present invention.

[0269] In accordance with some embodiments, reservoir management module **28** comprises a circuit board. In some embodiments, the circuit board is a microprocessor chip. In some embodiments, the circuit board comprises, or associates with, pump control circuit board.

[0270] In some embodiments, reservoir management module **28** comprises a communication unit, such as, communication unit **34**. In some embodiments, the circuit board of reservoir management module **28** communicates with the communication unit. Alternatively, communication between reservoir management module **28** and/or its circuit board and other components of system **100** is afforded by the communication unit.

[0271] Communication between reservoir management module **28** and its communication unit is required for various activities, including, but not limited to, transfer of data collected by reservoir management module **28** to stor-

age, such as, server **21**, through the communication unit, collection and transfer of data from one or more sensors connected to reservoir management module **28** to server **21**, collection and transfer of data from one or more modules connected to reservoir management module **28** to server **21**, for further analysis and processing of data, and the like.

[0272] In some embodiments, reservoir management module **28** comprises control switch (not shown) also termed on/off switch, configured to turn on/off reservoir management module **28**, or the activity of reservoir management module **28**. In some embodiments, the control switch is functionally associated with the circuit board of reservoir management module **28**. In some embodiments, the control switch is functionally associated with a switch control component functionally associated with the circuit board of reservoir management module **28**.

[0273] According to some embodiments, any of the modules disclosed herein can be customized to suit growth under any required condition for any type of plant. The modules can be programmed and monitored through user interface **33** which is encompassed in each module of system **100**.

[0274] Reference is now made to FIGS. **12** and **13** which present a flowchart of a method for tracking the contents of a feeding solution and replenishing it, and a flowchart of a method for tracking the contents of a feeding solution and draining it, respectively.

[0275] Accordingly, in some embodiments, there is provided a computer-implemented method for monitoring the level of components associated with plant growth, the method comprising the steps of:

[0276] (a) providing the system disclosed herein and a soil-less system comprising plants grown in a reservoir comprising a feeding solution;

[0277] (b) measuring, a plurality of times, the level of at least one component associated with plant growth;

[0278] (c) identifying a change in the at least one component, between an early measurement to at least one later measurement;

[0279] (d) determining that the identified change requires adjusting the contents of the feeding solution, wherein said identifying and determining is carried out by at least one of the server and the hydroponic device and comprises applying database interrogation on the at least one later measurement with respect to the data bank.

[0280] In some embodiments, the method further comprising repeating steps (b) to (e) periodically.

[0281] In some embodiments, the change in the at least one component, between an early measurement to at least one later measurement refers to deviation from a predefined level of said at least one component.

[0282] In some embodiments, said measuring is performed with the at least one sensor configured to measure the level of the at least one component associated with plant growth.

[0283] In some embodiments, the at least one component is selected from the group consisting of fluid level, pH, EC, nutrient, oxidation-reduction potential, temperature, minerals and total dissolved solids.

[0284] In some embodiments, the method further comprising adjusting the feeding solution by adding at least one solution comprising a required amount of the at least one component, thereby adjusting the feeding solution to include the predefined level of said at least one component, wherein the volume of the added solution, the time intervals between consecutive adding and the amount of the at least one component included therein are determined by at least one of the server and the hydroponic device.

[0285] In some embodiments, said adding to the feeding solution comprising transferring from one or more containers fluids that form the added solution.

[0286] In some embodiments, said adding comprises pumping through conduits fluidly connected to at least one pump.

[0287] In some embodiments, the method further comprising adjusting the feeding solution by draining a predetermined volume of feeding solution, wherein the volume of the drained feeding solution and the time intervals between consecutive draining are determined by at least one of the server and the hydroponic device.

[0288] In some embodiments, said continuously comprises a plurality of time per second.

[0289] In some embodiments, there is provided a method for monitoring the level of components associated with plant growth, the method comprising the steps of:

[0290] (a) providing a soil-less system comprising plants grown in a reservoir comprising a feeding solution;

[0291] (b) measuring, a plurality of times, the level of at least two components associated with plant growth, wherein at least one component is fluid level of the feeding solution in the reservoir, and wherein each of the remaining components associated with plant growth is associated with the contents of the feeding solution;

[0292] (c) identifying a negative change in at least one of the at least two components, between an early measurement to at least one later measurement;

[0293] (d) determining the contents and volume of fluids to be added to the feeding solution for obtaining a required fluid level and a required feeding solution contents, wherein a negative change in fluid level refers to decrease in the level of the feeding solution within the container and a negative change in each of the remaining components associated with plant growth refers to deviation from a predefined level of each of said remaining components, and wherein said determining the contents and volume of fluids to be added to the feeding solution comprises:

[0294] i. calculating the volume of fluids required to add, if any, to the feeding solution to reach the required fluid level of the feeding solution; and

[0295] ii. determining the concentration of each of the remaining components associated with plant growth in the calculated volume of fluids, required to add to the feeding solution to reach the predefined level of each of said remaining components and the required fluid level of the feeding solution,

[0296] (e) adding to the feeding solution a fresh fluid having said volume of fluids and said concentration of each of the remaining components, thereby obtaining a replenished feeding solution having the required fluid level and the predefined level of said each of the remaining components, or withdrawing a volume of fluids from the feeding solution thereby obtaining a feeding solution having the required fluid level and the predefined level of said each of the remaining components;

[0297] (f) repeating steps (b) to (e), periodically.

[0298] In some embodiments, the replenished feeding solution is also referred to as 'the current feeding solution'.

[0299] The required fluid level and the predefined level of said each of the remaining components (that provide the required feeding solution contents) are values calculated based on the type of irrigation water used at the location of the system and plants, the type of plants, the weather and any other specific parameter which is required for obtaining the desired growth and crop. These values are reference values, specific for each plant, environment (water, season), and stage of growth. These values are stored in storage media and used by the method and the system disclosed herein for calculating changes in fluid level of feeding solution contents, and for calculating the volume and contents of the fluids that need to be added to the feeding solution in order to bring it back to balance, when required.

[0300] In situations where the level of the feeding solution decreases (e.g. due to evaporation, and/or consumption by the plants), the concentrations of the various components of the remaining feeding solution increases, and the pH of the feeding solution changes. Thus, the method of the invention provides, through complicated calculations carried out by processors utilizing machine learning algorithms among others, the volume of fluids required to replenish the feeding solution, in order to meet a predefined fluid level, together with the concentration of one or more nutrients (nutrients, fertilizer and minerals, collectively referred to as nutrients) in said volume, such that, when the volume and contents of the added fluids bring the feeding solution to optimum, namely, to a fluid level that meets the predetermined fluids level and the contents that meets the predetermined contents.

[0301] In some embodiments, the machine learning algorithms used by the systems and methods disclosed herein, include, but are not limited to, linear regression, logistic regression, decision tree, SVM, Naive Bayes, kNN, K-Means, Random Forest, Dimensionality Reduction Algorithms and Gradient Boosting algorithms. Each possibility is a separate embodiment of the present invention.

[0302] Thus, in some embodiments, said identifying a negative change in at least one of the at least two components, between an early measurement to at least one later measurement, comprises identifying a negative change in the fluid level, thereby the contents of the fluids to be added to the feeding solution for obtaining the required feeding solution contents includes an amount of each of the remaining components that will complement the feeding solution such that when added in a volume that is required to reach the required fluid level will result with a replenished feeding solution having the required fluid level and the predefined level of said each of the remaining components.

[0303] In some embodiments, said identifying a negative change in at least one of the at least two components, between an early measurement to at least one later measurement, comprises identifying a negative change in at least one of the remaining components associated with plant growth, wherein the negative change in an overshoot in the concentration of at least one of the remaining components associated with plant growth, thereby step (e) comprises withdrawing a certain volume of fluids from the feeding solution thereby obtaining a feeding solution having the required fluid level and the predefined level of said each of the remaining components.

[0304] In some embodiments, step (e) further comprises adding to the feeding solution a volume of water, thereby obtaining a feeding solution having the required fluid level and the predefined level of said each of the remaining components. In some embodiments, the volume of water is a volume of RO water.

[0305] In some embodiments, said identifying a negative change in at least one of the at least two components, between an early measurement to at least one later measurement, comprises identifying a negative change in the fluid level and in the level of at least one of the remaining components, thereby the contents of the fluids to be added to the feeding solution for obtaining the required feeding solution contents includes an amount of each of the remaining components that will complement the feeding solution such that when added in a volume that is required to reach the required fluid level will result with a replenished feeding solution having the required fluid level and the predefined level of said each of the remaining components.

[0306] The terms 'required feeding solution contents' and 'predefined level of each of the remaining components' are interchangeable.

[0307] In some embodiments, the contents of the fluids to be added to the feeding solution for obtaining the required feeding solution contents includes an amount of each of the remaining components that will complement the feeding solution such that when added in a volume that is required to reach the required fluid level will result with a replenished feeding solution having the required fluid level and the predefined level of said each of the remaining components.

[0308] In some embodiments, measuring the fluid level of the feeding solution is carried out by at least one fluid level sensor.

[0309] In some embodiments, the remaining components associated with plant growth comprise pH and minerals.

[0310] In some embodiments, said measuring a plurality of times comprises measuring a plurality of time per second, a plurality of times per a tenth of a second, a plurality of times per a hundredth of a second, and plurality of time per millisecond. Each possibility is a separate embodiment of the present invention.

[0311] The term "plurality" as used herein refers to 'at least two' or 'two or more'.

[0312] In some embodiments, the frequency of measuring is determined by a user.

[0313] In some embodiments, the method further comprises providing a processor, the processor is associated with a storage media comprising a data bank comprising the required fluid level, the required feeding solution contents and the predefined level of each of said remaining components, and wherein the frequency of measuring is determined automatically by the server.

[0314] In some embodiments, the indicator provides an indication, if the change in fluid level is negative.

[0315] In some embodiments, the method further comprises:

[0316] (g) measuring the electrical conductivity of the feeding solution in parallel to fluid level measurements, according to steps (b) to (d);

[0317] (h) calculating the change in electrical conductivity, between an early measurement of electrical conductivity to at least one later measurement, and storing the calculated change in a server;

[0318] (i) adding fluids to the feeding solution, if at least one of the latest measurements of electrical conductivity indicates values outside a desired range of electrical conductivity, wherein the amount of fluids added results with feeding solution having a fluid level equal to the required fluid level and an electrical conductivity within the range of the desired range of electrical conductivity; and

[0319] (j) repeating steps (g) to (i).

[0320] In some embodiments, the measured electrical conductivity corresponds to the pH of the feeding solution.

[0321] In some embodiments, the latest measurements or measurement refers to the current measurement.

[0322] pH is a measure of acidity or basis of irrigation water. The pH level in the growth medium directly affects the ability of the roots to absorb nutrients. Each plant nutrition component has a pH range in which its absorption of the plant is maximum, however there is a range of pH in which all the essential components of the plant can be absorbed. Too high or too low levels of acidity will impair the ability of the plant to absorb the minerals and fertilizers from the irrigated water.

[0323] In some embodiments, the desired range of electrical conductivity corresponds to pH range of 5.5 to 6.0.

[0324] In some embodiments, the method further comprises:

[0325] (k) measuring the level of nutrients in the feeding solution in parallel to fluid level measurements, according to steps (b) to (d);

[0326] (l) calculating the change in nutrient level, between an early measurement of nutrient level to at least one later measurement, and storing the calculated change in a server;

[0327] (m) adding nutrient solution to the feeding solution, if at least one of the latest measurements of nutrient level indicates values outside a desired range of nutrient level, wherein the amount of nutrient solution added results with feeding solution having a fluid level equal to the required fluid level and nutrient level within the range of the desired range of nutrient level; and

[0328] (n) repeating steps (k) to (m).

[0329] In some embodiments, measuring the level of nutrients comprises identifying the one or more nutrients the level of which is deficient, and adding a nutrient solution comprising said one or more nutrients, wherein the volume of the added nutrient solution does not affect the fluid level of the feeding solution, or increases the fluid level of the feeding solution to the required fluid level, and wherein the concentration of said one or more nutrients in the volume of the added nutrients solution is a concentration providing the feeding solution a nutrient level within the range of the desired nutrient level, when added thereto.

[0330] It is to be understood that the concentration of the one or more nutrients required to reach again the desired range of nutrients is obtained by evaluating the amount of the one or more nutrients that is required to add, and providing this amount in a volume which does not affect the fluid level of the feeding solution, or increases the fluid level of the feeding solution to the required fluid level. This volume determines the concentration of the one or more nutrients in the added nutrient solution.

[0331] A volume of the added nutrient solution which does not affect the fluid level of the feeding solution, is a volume that is small enough, relative to the overall volume of the feeding solution, such that, when added, does not significantly change the contents and concentration of the various nutrients in the feeding solution. After fertilization, the pH is adjusted.

[0332] A non-significant change may be a change that is below detection levels or that is within the range of the required feeding solution contents.

[0333] It is to be understood that a required feeding solution contents refers to the pH and nutrients concentrations which meet the requirement and/or are optimal for the plant in the feeding solution, and its growth stage.

[0334] In some embodiments, the concentration of the one or more nutrients in the added nutrient solution is calculated by the circuitry board of the hub.

[0335] In some embodiments, the concentration of the one or more nutrients in the added nutrient solution is calculated by the circuitry board of the nutrient module.

[0336] In some embodiments, the concentration of the one or more nutrients in the added nutrient solution is calculated by the micro-processor of server **21**.

[0337] In some embodiments, said measuring the level of nutrients in the feeding solution comprising taking a photo of the plant(s) a plurality of times in a given time period.

[0338] In some embodiments, said calculating the change in nutrient level, between an early measurement of nutrient level to at least one later measurement comprising comparing each photo in the plurality of photos to a reference scale, and applying image analysis to determine change in said each photo relative to the reference scale, wherein a negative change indicates nutrient deficiency.

[0339] In some embodiments, each photo is a colored photo. In some embodiments, the reference scale is a color scale comprising a range of colors relevant to the plant grown in the system, wherein part of the color scale correspond to the colors of a healthy plant, and other parts of the scale correspond to the color of the plant under various nutrient deficiencies.

[0340] In some embodiments, the comparison (image analysis) is carried out by server **21**.

[0341] According to some embodiments, a computer-implemented method for optimal soilless plant growing is presented herein. The method compares parameters of the plant growth and of environmental conditions to an optimal growth profile of the soilless plant and identifies if there is a change from the optimal growth profile which indicates a problem in the growth of the plant. The method considers dynamic financial parameters such as the different costs required for growing the plant and provides recommendation whether to discontinue growing the plant or provide one or more modifications in the growth or environmental parameters to overcome the problem and adjust the growth of the plant to the optimal growth profile.

[0342] FIG. **14** Schematically shows a flow chart of a computer-implemented method for optimizing soilless plant growing, according to some embodiments. At step **1402**, according to some embodiments one or more growth parameters related to growth of the plant and one or more environmental parameters are monitored. The parameters may be continuously monitored or temporarily measured at different time periods. In some embodiments, the one or more parameters related to the growth of the soilless plant comprises a large variety of parameters (it may get to hundreds of parameters or more), for example, height of the

plant, weight of the plant/product, number or area of leaves of the plant, number of fruits of the plant, number of flowers of the plant, mineral content of the plant/product, sugar content of the plant/product, color of the plant/product, water consumption rate of the plant, and the like. According to some embodiments, the environmental parameters includes for example, water pH, nutrient level in the water, temperature, humidity, light conditions, or any combination thereof.

[0343] At step **1404**, according to some embodiments, the one or more growth parameters and environmental parameters are compared to growth parameters and environmental parameters of an optimal growth profile of the plant. The optimal growth profile is generated by machine learning algorithms trained on a plurality of growth profiles of a plurality of soilless plants. In some embodiments, the plurality of growth profile of the plurality of soilless plants include a growth profile as a function of water consumption. In some embodiments, the optimal growth profile is generated by the ML algorithms based on data from the data bank, which is a dynamic data bank comprising data from water facilities worldwide, a plurality of measurements of growth parameters of a plurality of soilless plants, a plurality of measurements of environmental parameters of the plurality of soilless plants, a plurality of measurements associating water consumption to plant strain or type with different environmental parameters and a plurality of measurements of the product producible by/from the soilless plant. In some embodiments the optimal growth profile is defined by the ML algorithms based on the plurality of measurements of growth and environmental parameters of the soilless plant in accordance with the measurements of product producible by/from the plant. According to some embodiments, the optimal growth profile may define a value or a range of values for a parameter of growth along time. For example, the parameter of the number of flowers for a specific soilless plant may be optimally, 0 flowers before day 60 of the growth cycle and about 5 flowers on days 60-65 of the growth cycle. According to some embodiments, alternatively or additionally the optimal parameter may be between 5-10 flowers on days 60-65 of the growth cycle. According to some embodiments, in some cases an optimal parameter may be defined as an approximated value such that 90%-110% of the approximated value are also considered optimal.

[0344] At step **1406**, according to some embodiments, it is identified if there is a change from the growth parameters of the optimal growth profile. The change from the optimal growth profile may indicate a problem in the growth of the plant or in the environmental parameters of the plant. For example, referring to the parameter of number of flowers, if there are flowers 60 days have passed of the growth cycle it is too early and takes energy from the plant to grow the flowers instead of strengthening the roots and leaves which may lead to less product from the plant.

[0345] At step **1408**, dynamic financial parameters relating to a cost of the plant growth and market price for the plant or a product producible by/from the plant are received. This step may be carried out earlier, for example, before or after step **1402** of monitoring the growth and environmental parameters of the plant. The dynamic financial parameters include for example, electricity cost, water cost, manpower cost, nutrients cost, and the like or any combination thereof. In some embodiments, the product producible by/from the plant comprise: fruits, roots, leaves, flowers and the like.

[0346] At step **1410**, according to some embodiments, a prediction score is generated based on the one or more monitored growth and environmental parameters and the dynamic financial parameters. The prediction score considers the actual growth of the plant in comparison to the optimal growth profile and the financial parameters needed for growing and/or continuing growing the plant. In addition, according to some embodiments, the prediction score also predicts the future growth profile of the plant. In some embodiments, the prediction score is generated using a prediction function. In some embodiments, the prediction function is generated by Machine Learning (ML) algorithms. In some embodiments, the ML algorithms are trained on a plurality of growth and respective environmental parameters derived from a plurality of plant growth cycles in a plurality of plant samples and financial parameters.

[0347] At step **1412**, it is checked if the prediction score is below a predefined threshold, which denotes economic unviability. If the prediction score is below the predefined threshold, then at step **1414**, a recommendation to discontinue growing of the plant is outputted, based on the generated prediction score. Else if the prediction score is at or above the predefined threshold, then according to some embodiments, at step **1416** one or more modifications in the one or more growth and/or environmental parameters is outputted, to adjust the growth profile of the soilless plant to the optimal growth profile. According to some embodiments the threshold may be a range of values such that the prediction score is above, below or at the range of values. For example referring to the example of the number of flowers before day 60 of the growth cycle, in case there are flowers before 60 days of the growth cycle have passed, a possible modification may be to pick down the flowers.

[0348] According to some embodiments, a computerized method for automatically providing an optimal growth protocol of a soilless plant is presented herein. The method includes:

[0349] (a) defining a plant growth optimal outcome (success criterion);

[0350] (b) providing an initial plant growth outcome and an initial corresponding growth protocol obtained from an initial experiment;

[0351] (c) applying the initial plant growth outcome and the corresponding initial growth protocol to ML algorithms, trained on a plurality of plant growth outcomes and corresponding growth protocols;

[0352] (d) outputting a modified growth protocol by the ML algorithms, wherein the first growth protocol comprises a plurality of modifications compared to the initial growth protocol;

[0353] (e) obtaining a resulted plant growth outcome of a plant grown according to the first growth protocol; and

[0354] if the resulted plant growth outcome is inferior to the defined plant growth optimal outcome, repeating steps (c) (by applying the resulted plant growth outcome and the corresponding modified growth protocol to ML algorithms)-(e) until the resulted plant growth outcome is equal to or exceeds the defined plant growth optimal outcome.

[0355] In some embodiments, the growth protocol includes the growth conditions of the plant and timing and

duration for each condition, for example: amounts of nutrients, number of times to add nutrients, times for adding nutrients, pH level, amount of water, light conditions, weather conditions, humidity conditions and the like. According to some embodiments, providing the optimal growth protocol of the soilless plant saves time and costs in growing the soilless plant.

[0356] In some embodiments, there is provided a method for generating a water consumption rate profile of a soilless plant in hydroponic systems. The water consumption rate profile teaches about the growth of the plant and a change in the water consumption rate profile in comparison to an average water consumption rate profile of the type of plant may indicate problems such as diseases of the plant. The advantage of the water consumption profile is that it indicates the problem at an early stage before the disease effects are evident in the growth parameters of the plant. The early identification of the problem allows to provide solution and/or treatment to the plant before damage is done to the plant. The method includes:

[0357] measuring the amount of water and/or water added to the hydroponic device to estimate plant water consumption rate, wherein the hydroponic device is a closed system;

[0358] comparing the estimated water consumption rate to an average water consumption rate profile of the plant, wherein the optimal water consumption rate profile is generated by machine learning (ML) algorithms trained on a plurality of water consumption rate estimates based on water amount and/or added water amount measurements of a plurality of soilless plants and is based on data from the data bank;

[0359] identifying a change from the average water consumption rate growth profile.

[0360] In some embodiments the method further comprises measuring one or more growth parameters of the plant and estimating the growth of the plant as a function of the one or more growth parameters and water consumption rate of the plant, and outputting modifications for adjusting the water consumption rate of the plant to the average water consumption rate profile.

[0361] In some embodiment the modifications may be a treatment for a disease of the plant or a change in the environmental parameters of the plant or in the feeding of the plant and the like.

[0362] In some embodiments, the average water consumption profile is an optimal water consumption profile based on measurements of the water amount and/or water added amount (i.e., water consumption), one or more growth parameters and product producible by/from the plant.

[0363] In some embodiments, the ML algorithms are trained on a plurality of growth parameters derived from a plurality of plants and their associated water consumption and is based on data from the data bank.

[0364] In some embodiments, the ML algorithms may provide a plurality of plants growth profiles and their water consumption.

[0365] In some embodiments the growth parameters may be height of the plant, weight of the plant, number or area of leaves of the plant, number of flowers of the plant, number of fruits of the plant, mineral content of the plant, sugar content of the plant, color of the plant, and the like.

[0366] In some embodiments, the method further comprises identifying a change in the water consumption profile or in the water consumption rate of the plant comparing to the water consumption profile, which may indicate a problem in the plant growth.

[0367] The methods disclosed herein enable to model management of soil-less growing techniques, buy continuous real-time measuring, storing and calculating changes overtime, of various parameters in the plant and the feeding solution, as exemplified in FIGS. **12-13**. This intelligent approach allows learning the influence of each parameter, and hence develop improved, time consuming and cost-effective methods and system of soil-less plant growth.

[0368] It is appreciated that certain features of the disclosure, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the disclosure, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable sub-combination or as suitable in any other described embodiment of the disclosure. No feature described in the context of an embodiment is to be considered an essential feature of that embodiment, unless explicitly specified as such.

[0369] Although steps of methods according to some embodiments may be described in a specific sequence, methods of the disclosure may include some or all of the described steps carried out in a different order. A method of the disclosure may include a few of the steps described or all of the steps described. No particular step in a disclosed method is to be considered an essential step of that method, unless explicitly specified as such.

[0370] Although the disclosure is described in conjunction with specific embodiments thereof, it is evident that numerous alternatives, modifications and variations that are apparent to those skilled in the art may exist. Accordingly, the disclosure embraces all such alternatives, modifications and variations that fall within the scope of the appended claims. It is to be understood that the disclosure is not necessarily limited in its application to the details of construction and the arrangement of the components and/or methods set forth herein. Other embodiments may be practiced, and an embodiment may be carried out in various ways.

[0371] The phraseology and terminology employed herein are for descriptive purpose and should not be regarded as limiting. Citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the disclosure. Section headings are used herein to ease understanding of the specification and should not be construed as necessarily limiting.

1. A computer-implemented method for optimized soilless plant growing, the method comprising:

monitoring, one or more growth parameters related to growth of the plant and one or more environmental parameters;

comparing the one or more growth parameters and environmental parameters to growth parameters and environmental parameters of an optimal growth profile of the plant, wherein the optimal growth profile is generated by machine learning algorithms trained on a plurality of growth profiles of a plurality of soilless plants;

identifying a change from the optimal growth profile;

receiving dynamic financial parameters relating to a cost of the plant growth and market price for the plant or a product producible by/from the plant;

generating a prediction score based on the one or more monitored growth and environmental parameters and the dynamic financial parameters; and

outputting, based on the generated prediction score, a recommendation to discontinue growing of the plant if the prediction score is below a predefined threshold; or

if the prediction score is at or above the predefined threshold, outputting one or more modifications in the one or more growth and/or environmental parameters to adjust the growth profile of the soilless plant to the optimal growth profile.

2. The method of claim **1**, wherein the optimal growth profile is generated by the ML algorithms based on data from a data bank, which is a dynamic data bank comprising data from water facilities worldwide, a plurality of measurements of growth parameters of a plurality of soilless plants, a plurality of measurements of environmental parameters of the plurality of soilless plants, a plurality of measurements associating water consumption to plant strain or type with different environmental parameters and a plurality of measurements of the product producible by/from the soilless plant.

3. The method of claim **1**, wherein the plurality of growth profile of the plurality of soilless plants comprise a growth profile as a function of water consumption.

4. The method of claim **1**, wherein the prediction score is generated using a prediction function.

5. The method of claim **4**, wherein the prediction function is generated by Machine Learning (ML) algorithms.

6. The method of claim **4**, wherein the ML algorithms are trained on a plurality of growth and respective environmental parameters derived from a plurality of plant growth cycles in a plurality of plant samples and financial parameters.

7. The method of claim **1**, wherein the one or more growth parameters comprise: height of the plant, weight of the plant/product, number or area of leaves of the plant, mineral content of the plant/product, sugar content of the plant/product, color of the plant/product, water consumption rate of the plant, or any combination thereof.

8. The method of claim **1**, wherein the one or more environmental parameters comprise: water pH, nutrient level in the water, temperature, humidity, light conditions, or any combination thereof.

9. The method of claim **1**, wherein the dynamic financial parameters comprise: electricity cost, water cost, manpower cost, nutrients cost, or any combination thereof.

10. The method of claim **1**, wherein the product producible by/from the plant comprise: fruits, roots, leaves, flowers, or any combination thereof.

11. A computerized method for automatically providing an optimal growth protocol of a soilless plant, the method comprising:

(a) defining a plant growth optimal outcome (success criterion);

(b) providing an initial plant growth outcome and an initial corresponding growth protocol obtained from an initial experiment;

(c) applying the initial plant growth outcome and the corresponding initial growth protocol to ML algorithms, trained on a plurality of plant growth outcomes and corresponding growth protocols;

(d) outputting a modified growth protocol by the ML algorithms, wherein the first growth protocol comprises a plurality of modifications compared to the initial growth protocol;

(e) obtaining a resulted plant growth outcome of a plant grown according to the first growth protocol; and

(f) if the resulted plant growth outcome is inferior to the defined plant growth optimal outcome, repeating steps (c) (by applying the resulted plant growth outcome and the corresponding modified growth protocol to ML algorithms)-(e) until the resulted plant growth outcome is equal to or exceeds the defined plant growth optimal outcome.

12. The method of claim **11**, wherein the growth protocol related to growth conditions of the soilless plant and timing and duration for each condition, and comprises amounts of nutrients, number of times to add nutrients, times for adding nutrients, amount of water to add, and times for adding the amount of water, light conditions, weather conditions, humidity conditions and any combination thereof.

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