AN AEROPONIC PLANTING SYSTEM

[001] The invention relates to the technical field of agricultural planting, in particular, an aeroponic planting system that operates in an automated manner.

BACKGROUND OF THE INVENTION

[002] As more and more people live in cities to look for better job opportunities, a soaring urban population means a soaring requirement for food. At present, more than half the world's population live in cities. According to an estimate from the United Nations, about 65% of the world's population will be living in cities by 2050, and this will bring great challenges to the food supply chain.

[003] Urban farming, with its ability to produce more food with lesser land, can mitigate this challenge. However, because the economic benefit from farming is little, most young people are reluctant to take up farming as a profession, leading to ageing farmers globally. In order to have sufficient food in the future, the incomes of farmers will need to be increased to make farming attractive to young people. To achieve this, the productivity of farming will need to be increased to expand the scale of production and economic benefits through specialized production methods.

[004] Traditional farming requires a lot of land and water resources, but these resources are limited. Hence, aeroponic farming is one of modern agriculture's most efficient planting techniques. In aeroponic farming, as the roots of the grown vegetables grown are suspended in the air with liquid nutrients being sprayed at the roots in mist form through nozzles, faster growth of the vegetables is promoted, and this popularising aeroponic farming. This invention provides a means for aeroponic farming that intends to solve the global problems of limited water and farmland resources.

[005] Among disclosed technologies over the prior art that may relate to aeroponic planting system include Chinese Pat. No. CN201509480U, which discloses a trapezoid-shaped three-dimensional aeroponic planting system. It comprises several components, including a nutrient solution aerosol feed system, a trapezoidal planting plate, a high-pressure water pump, and a nutrient solution pool that is independent of the other components The nutrient

solution aerosol feed system includes a spray head support bracket and multiple spray heads connected to it via pipes. The three-dimensional planting plate features spaced planting holes with adhesive bodies for seed attachment.

[006] However, in the aforementioned prior art, its system is in the form of steel structures comprising one or more individual component parts. These loose parts are connected and installed by welding and the usage of bolts and nuts. Since the component parts are produced manually, it is difficult to achieve high precision for these parts, resulting in correction and rework during installation due to the inaccuracy of dimensions. s time-consuming and laborious, resulting in construction costs higher than material costs. During the installation and connection of these parts, it is very difficult to achieve very good sealing between every piece of the installed and connected parts, which will result in the leakage of nutrient solution to the outside of the trapezoid during irrigation. This leakage not only increases the operating cost but will also cause the growth of algae on the outside surfaces of the planting boards when the leaked nutrient solution comes into contact with sunlight, damaging the planting boards and the vegetables. As the plant growth area needs to be connected by piping to the external independent nutrient solution pool which is located outside the plant growth area, where the high-pressure pump is located, hydraulic calculation is required to be performed to ensure that the flow is sufficient to satisfy the requirement of the complete plant growing area. The further the external independent nutrient solution pool is located from the plant growing area, the higher the costs of the pump and the related installation work.

[007] Furthermore, in the aforementioned prior art, in order for the excess nutrient solution to return to the nutrient solution pool, a piping connection is required. Within the piping connection, the return line pipes have long lengths, hence, a sterilisation device is required to be installed to the said return line pipes. However, this could cause the nutrient solution to be infected. To ensure that the nutrient solution in the return line pipes passes through the sterilisation device at the required speed for proper sterilization, the speed of the nutrient solution may be reduced by the installation of a buffer trench and buffer walls, which increase the installation time and overall costs.

[008] Furthermore, in the aforementioned prior art, to reduce the wastage of nutrient solution, a sloped trench has to be dug below the trapezoid-shaped planting plates for excess nutrient solution dripping from the roots of the vegetables to flow back to the nutrient solution pool.

This type of planting technique can only be used on a traditional farmland, the supply of which is decreasing globally, and is therefore not suitable for the promotion of urban farming, especially soilless farming, to cater to the increasing global urban population. Due to the high site installation costs and long construction time of the technique in this prior art, this technique is unsuitable for highly productive and highly efficient urban farms which are being promoted globally.

[009] Furthermore, in the aforementioned prior art, the plants grown thereon are unable to naturally grow in an upwards direction. It is to be noted that all plants, including vegetables, grow vertically upwards according to nature. However, in this prior art, when the planting plate on both sides of the frames of the trapezoid are placed in a slanted manner, the 90-degree holes which are drilled onto the planting holes in the planting boards will not be in an upright position, and the vegetables inside these planting holes are not able to grow vertically upwards naturally, thus affecting their growth.

[0010] Furthermore, in the aforementioned prior art, its related techniques depend solely on manual labour for placing each piece of culture medium, with seedlings accommodated therein, into the holes of the planting plate. When harvesting of the grown vegetables is to be done, it is again solely dependent on manual labour for removing each and every vegetable from the planting holes, putting the vegetables into baskets, and manually carrying these baskets along the narrow passageways between the rows of planting trapezoid frames to the collection points, and returning to the last picking position. Hence, its related techniques are labour-intensive and time-consuming, thereby leading to low productivity and low economic benefits. The bigger the farm, the more manpower it will require. With the present global problem of ageing farmers, and the work involved being outdoor labour-intensive work, there is a lot of difficulty in addressing the labour shortage problem, especially in attracting young people.

[0011] Therefore, the aforementioned prior art has limited practical usage and is not conducive to the promotion of agricultural industrialisation to transform farmers into blue-collar workers, as claimed by this present invention.

SUMMARY OF INVENTION

[0012] The main objective of the present invention is to provide an aeroponic planting system deployable in open spaces and greenhouses such as traditional greenhouses and containerised greenhouses. A further objective of the present invention is to provide a collapsible unit that forms a containerised greenhouse that is deployable together with the aeroponic planting system.

[0013] Advantageously, in the present invention, by installing a controller with sensors in an aeroponic planting system for planting in open spaces, an automatic fertilisation and irrigation of the system is achieved. More specifically, a control over a starting and stopping of the nutrient liquid distribution pump is enabled using the sensor data collected by the sensors, which monitors the humidity and temperature at the root section of the vegetables. With this, the present invention provides a more accurate aeroponic management compared to conventional techniques that involve monitoring of a surrounding open space of the plants to determine their humidity and temperature.

[0014] Advantageously as well, in the present invention, the controller further provides control over equipment, such as an automatic starting/stopping of ventilation fans and heaters, and an automatic opening/closing of ventilation dampers, especially when used in greenhouses such as traditional greenhouses or containerised greenhouses. As such, this effectively solves the problem of high-power consumption due to the non-stop operation of the nutrient liquid distribution pump, and also avoids premature failure of the pump. Moreover, through the extension of the branch pipe from the nutrient liquid distribution pump, nutrient liquid is sprayed accurately onto the plants within at least one planting tower.

[0015]Advantageously as well, the present invention provides a foldable containerised greenhouse, which can be folded up for shipment, thereby significantly reducing the shipment cost. In particular, the manpower and time required to erect the foldable containerised greenhouse onsite, by the end user, is reduced significantly. Moreover, since the foldable containerised greenhouse is already pre-assembled at the factory, it is only required to just open it up from its folded condition for its erection.

[0016] Advantageously as well, the present invention provides a foldable containerised greenhouse that is fully automated and solar-powered, which makes it possible to utilise sunlight to plant vegetables without requiring LED lights to be installed inside the containers of the containerised greenhouse, as practised by conventional containerised vertical farms. This leads to substantial savings on power consumption, which further leads to much lower prices of the vegetables that benefit the consumers. Such a greenhouse can be deployed and located near the customers such as wet markets and supermarkets, and also in strategic or remote places with small populations, which makes it commercially unviable to set up large traditional greenhouses.

[0017] Advantageously as well, the present invention provides an automatic seed-sowing device, an automatic seedling-transferring device, and an automatic placement-collection mechanism. This replaces the existing need for many workers to tear off the sponge pieces grown with vegetable seedlings from the sponge sheet piece by piece. Furthermore, this does away the repeatedly bending of the workers' bodies and lifting of their hands to manually insert the countless number of sponge pieces grown with vegetable seedlings into the planting holes of the planting boards piece by piece. Hence, this greatly reduces the labour and the time-consuming work, thereby effectively solving the existing common problem of difficulty in finding young workers to engage in agriculture.

[0018] Advantageously as well, the present invention provides a robotic arm installed on an automated guided vehicle (AGV) to transport the planting boards, having been inserted with sponge pieces with seedlings, from the transport rack to the holding studs on the frames of the planting towers, collect the side boards and top boards with grown vegetables from the planting towers, place these side boards and top boards onto the transport rack, and transport them to an automatic root-cutting device for automatic cutting of the roots of the vegetables. This also effectively solves the existing common problem of difficulty in finding young workers to engage in agriculture by greatly increasing the productivity and therefore the incomes to allow the farmers to achieve prosperity. At the same time, agricultural factories can be built quickly and accurately at lower construction costs and be applied on high-efficiency and high-yield urban farms which are being promoted by more and more cities to solve the problem of insecurity of the urban food chain.

[0019] The technical problem to be solved by the present invention is the complicated installation as required in the prior arts, which makes the prior arts require a high construction cost and a need to employ many workers for planting and harvesting of vegetables.

[0020] To solve the above technical problem, the present invention intends to provide an aeroponic planting system, comprising a base tray, at least one planting tower providing a growing area for plants, which is installed on the base tray, a nutrient liquid distribution tank storing nutrient liquid, a mist device that includes a nutrient liquid distribution pump that is in connection with the nutrient liquid distribution tank and mist nozzles that are in substantial connection with the nutrient liquid distribution pump that spray nutrient liquid to cover roots of the plants that are within an enclosed space of the planting tower, a first heat and humidity sensor installed within the enclosed space of the planting tower, and a controller that is interfaced with the first heat and humidity sensor and the mist device. The controller provides an automated control of the nutrient liquid distribution pump of the mist device based on the temperature and humidity within the enclosed space of the planting tower as measured by the first heat and humidity sensor.

[0021] Optionally, for enabling the aeroponic planting system to be suitable for use in greenhouses such as traditional greenhouses or containerised greenhouses, the aeroponic planting system may further comprise a second heat and humidity sensor installed outside of the planting tower that is interfaced with the controller, and one or more pieces of equipment that include ventilation dampers, ventilation fans, and heaters, which are interfaced with the controller. With this, the controller further provides an automated control of the nutrient liquid distribution pump of the mist device and the equipment based on the temperature and humidity within the enclosed space of the planting tower and outside of the planting tower as measured by the first heat and humidity sensor and the second heat and humidity sensor.

[0022] Optionally, regarding the aeroponic planting system, its planting tower further comprises side boards that are formed by a plurality of board pieces, end boards, and top boards. The side boards are in connection with the pair of end boards, and the top boards are located atop the side boards and end boards, and are in connection therewith them.

[0023] Optionally, regarding the planting tower of the aeroponic planting system, its side boards and the top boards are formed with planting holes that are each in connection with the enclosed spaced within the planting tower, with each planting hole having culture medium disposed therein.

[0024] Optionally, the mist device of the aeroponic planting system comprises at least one inlet pipe which is connected to an inlet of nutrient liquid distribution pump, at least one outlet pipe which is connected to the outlet of nutrient liquid distribution pump, and branch pipes that penetrate through the end boards of the planting tower that provide a connection between the outlet pipe and the mist nozzle.

[0025] Optionally, the mist device of the aeroponic planting system further comprises a liquid filter and a magnetic processor, which are both installed on the outlet pipe, with the liquid filter located nearer to the nutrient liquid distribution pump compared to the magnetic processor.

[0026] Optionally, the aeroponic planting system further comprises an inverter and solar panels, wherein the solar panels provide power to the system via the inverter using solar energy.

[0027] Optionally, the aeroponic planting system further comprises gas equipment and at least one gas sensor that is interfaced with the controller, wherein the controller provides further provides an automated control of the gas equipment based on gas concentration levels measured by the gas sensor.

[0028] Preferably, the aeroponic planting system further comprises a seed-sowing device that operates in an automated manner, which comprises a sponge storage container, an unsown sponge conveyor, a sown sponge conveyor, a set of pneumatic cylinders installed on the unsown sponge conveyor and sown sponge conveyor, a limiter cylinder for sowing, a vacuum device that moves in one or more directions, a perforated panel that moves in one or more directions, a seed tray and a vibrating device for the said seed tray that both are installed on the sown sponge conveyor, and a cabinet in which the unsown sponge conveyor and the sown sponge conveyor are installed thereabove.

[0029] Optionally, regarding the seed-sowing device of the aeroponic planting system, its pneumatic cylinders control the movements of the vacuum device and movements of the perforated panel.

[0030] Preferably, the aeroponic planting system further comprises a seedling-transferring device that operates in an automated manner, which comprises a traverse manipulator module, a vertical manipulator module, and a separation manipulator module having a plurality of grippers and a servo motor screw structure.

[0031] Optionally, regarding the seedling-transferring device of the aeroponic planting system, it further comprises a first conveyor installed with a sponge piece, a second conveyor to be installed with one board from the side boards or the top boards of planting tower, with each conveyor being installed with sensors.

[0032] Preferably, the aeroponic planting system further comprises a placement system, which comprises an automatic placement-collection mechanism for placing and collecting boards from the side boards or the top boards of planting tower, which includes a compound automated guided vehicle installed with a visualiser and a bar code reader, a transport rack having a drawbar, and a robotic arm that has grippers, and a machine-assisted placement device, which includes a vehicle that has an internal combustion engine or an electrical engine, a controller, a guardrail, a storage rack, and a hand gripper

[0033] Preferably, the aeroponic planting system further comprises an automatic root-cutting device, which comprises a cutting table, a mounting port for receiving boards from the side boards or the top boards of planting tower, an automatic clamp that is controlled by a solenoid valve for clamping boards from the side boards or the top boards of planting tower, a pneumatic cylinder, a cutter, a container for vegetable roots, more than one limit switches, and an air compressor.

[0034] Optionally, regarding the automatic root-cutting device of the aeroponic planting system, its limit switches include a first limit switch that is installed on a top left end of the cutting table, and a second limit switch that is installed next to the automatic clamp.

[0035] Preferably, the aeroponic planting system further comprises an automatic vegetable-packing device, which comprises a vegetable conveyor, a packaging unit that includes a motor, a drive roller, a packaging film, a feed conveyor, and a shaper; and a delivery unit.

The packaging unit is installed on top of the vegetable conveyor and connected thereto, and the delivery unit is installed on a right end side of the vegetable conveyor, and operates in conjunction with the packaging unit.

[0036] The present invention further intends to provide a collapsible unit for forming a greenhouse, in particular a containerised greenhouse, which has an aeroponic planting system. The collapsible unit comprises one or more rigid poles that include a set of rear poles that comprises a first rear pole and a second rear pole, and a set of front poles, one or more rigid beams that include a set of rear beams that comprises a first rear beam and a second rear beam, and a set of front beams, and one or more foldable beams that include first foldable beams and second foldable beams. The rear beams each are in a rigid connection between top ends or bottom ends of each rear pole, and the front beams each are in a rigid connection between top ends or bottom ends of each front pole, and the first foldable beams are in a hinged connection between top ends or bottom ends of each front poles, and the second foldable beams are in a hinged connection between top ends or bottom ends of each rear poles.

[0037] Optionally, the unit further comprises a floor board that is in a hinged connection with a side of the second rear beam, which forms a floor when it is lowered down to assume a flat position.

[0038] Optionally, the unit further comprises a first frame being in a rigid connection with the set of rear poles that holds in place a rear board, a second frame being in a hinged connection with a side of the first rear beam that holds in place a ceiling board, a third frame being in a hinged connection with a side of the first rear pole that holds in place a front door, a fourth frame being in a hinged connection with a side of the second rear pole that holds in place a back door, and a fifth frame being in a rigid connection with sides of the front poles that holds in place a front board.

[0039] Optionally, the unit is connectable with units of the same to form a greenhouse, through defined by their doors and/or their front boards, wherein the doors of units located at distal ends of the formed greenhouse are to only remain, and the front boards of units located at distal ends of the formed greenhouse are to only remain.

[0040] One skilled in the art will readily appreciate that the invention is well adapted to carry out the objects and obtain the ends and advantages mentioned, as well as those inherent therein. The embodiments described herein are not intended as limitations on the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] To facilitate an understanding of the invention, there is illustrated in the accompanying drawings the preferred embodiments from an inspection of which when considered in connection with the following description, the invention, its construction and operation and many of its advantages would be readily understood and appreciated.

[0042] FIG. 1a is a schematic illustration of the main functional components of the aeroponic planting system for use in **open spaces** according to the present invention.

[0043] FIG. 1b is a schematic illustration of the main functional components of the aeroponic planting system for use in greenhouses such as **traditional greenhouses** or **containerised greenhouses** according to the present invention.

[0044] FIG. 2 is a 3-dimensional structural drawing of the aeroponic planting system without the mist device.

[0045] FIG. 3a is a 3-dimensional drawing of a collapsible unit that forms a containerised greenhouse, the collapsible unit in a partially-folded condition.

[0046] FIG. 3b shows a containerised greenhouse formed by several collapsible units that are connected with one another.

[0047] FIG. 4 is an example home page screen of the controller of the present invention.

[0048] FIG. 5 is a 3-dimensional drawing of the automatic seed-sowing device.

[0049] FIG. 6 is a 3-dimensional drawing of the automatic seedling-transferring device.

[0050] FIG. 7 is a 3-dimensional drawing of the enlarged view of the servo motor screw structure and the grippers of the separation manipulator.

[0051] FIG. 8 is a schematic illustration of the main functional components of the automatic placement-collection mechanism of the planting boards for vegetables.

[0052] FIG. 9 is a schematic plan view of the hand gripper, and the side and top planting boards for vegetables.

[0053] FIG. 10 is a 3-dimensional drawing of the transport rack.

[0054] FIG. 11 is a schematic illustration of the main functional components of the machine-assisted placement-collection device of the planting boards for vegetables.

[0055] FIG. 12 is a 3-dimensional drawing of the automatic root-cutting device with the pneumatic cylinder arm in its initial condition.

[0056] FIG. 13 is a 3-dimensional drawing of the automatic root-cutting device with the pneumatic cylinder arm in its extended condition.

[0057] FIG. 14 is a 3-dimensional drawing of the automatic vegetable packing device.

DETAILED DESCRIPTION OF THE INVENTION

[0058] The invention will now be described in greater detail, by way of example, with reference to the figures. For ease of reference, common reference numerals or series of numerals will be used throughout the figures when referring to the same or similar features common to the figures.

[0059] Referring to **FIG. 1a** and **FIG. 2**, an embodiment of the aeroponic planting system for installation in an open space is shown. The system includes at least one planting tower **1**, a base frame comprising a base tray **2** and a tray support **13** wherein the planting tower **1** is installed on the base tray **2**, a recycled nutrient liquid tank **9** that is installed below the base tray **2**, a nutrient liquid distribution tank **24**, a mist device that is connected to the nutrient liquid distribution tank **24** for delivering a mist spray within least one planting tower **1** via its mist nozzles **7**, a first combined humidity and temperature sensor **26** located within an enclosed space of the planting tower **1**, and a controller **27**. The controller **27** is connected to the mist device and the first combined humidity and temperature sensor **26**, where the mist device is operatively controlled by the controller **27** as per its humidity and temperature settings based on the humidity and temperature as detected by the first combined humidity and temperature sensor **26**. Based on this, the mist device delivers nutrient liquid to the vegetables grown within the planting towers **1** via its mist nozzles **7** by misting nutrient liquid to cover the roots of all the said vegetables in their entirety.

[0060] With reference to **FIG. 1a** and **FIG. 2**, the planting tower **1** comprises one or more perforated boards, with each perforation forming planting holes **4**. The planting holes **4** are shaped in the form of cylindrical structures and are slanted. A culture medium **5** is to be placed in each planting hole **4**.

[0061] With reference to **FIG. 1a** and **FIG. 2**, the mist device further comprises an inlet pipe **18** that is connected to the nutrient liquid distribution pump **10**, and an outlet pipe **8** that is connected to an outlet of the nutrient liquid distribution pump **10**. The mist nozzles **7** are connected to branch pipes **6** that penetrate through holes **121** on the end boards **12** of the planting tower **1**, and are further connected to the outlet pipe **8**.

[0062] With reference to **FIG. 1a** and **FIG. 2**, the system further comprises a liquid filter **20** for filtering dirt in the nutrient liquid, and a strong magnetic processor **21** for preventing crystallisation of the nutrient liquid which could lead to clogging of the mist nozzles **7** located at its downstream. The liquid filter **20** and the strong magnetic processor **21** are installed along the outlet pipe **8**, with the liquid filter **20** being nearer to the nutrient liquid distribution pump **10** compared to the strong magnetic processor **21**.

[0063] With reference to **FIG. 1a** and **FIG. 2**, the system further comprises one or more drain pipes **11** that allow excess nutrient liquid collected by the base tray **2** to flow by gravity into the recycled nutrient liquid tank **9**. The excess nutrient liquid collected by the base tray **2** may have dripped or trickled down from the mist nozzles **7** or the walls of the boards to the base tray **2**. The system further comprises a return flow pump **15** that is installed between the piping of the recycled nutrient liquid tank **9** and the nutrient liquid distribution tank **24** to pump the recycled nutrient liquid from the recycled nutrient liquid tank **9** back to the nutrient liquid distribution tank **24**.

[0064] With reference to **FIG. 1a** and **FIG. 2**, the system further comprises a fertiliser tank **25**. Further included is a replenishment pump **23** that is installed between piping of the nutrient liquid distribution tank **24** and the fertiliser tank **25**, for replenishment of fertiliser from the fertiliser tank **25** to the nutrient liquid distribution tank **24**. A motorised mixer is installed on both the nutrient liquid distribution tank **24** and the fertiliser tank **25** to ensure a proper mixture of the nutrient liquid and the fertiliser.

[0065] With reference to **FIG. 1a** and **FIG. 2**, the system further comprises a solenoid valve **14** that is installed between piping of a water supply inlet and the nutrient liquid distribution tank **24** to allow an automatic opening and/or closing of the water supply inlet. Furthermore, there are distribution solenoid valves **17** that are installed upon the piping connection before the branch pipes **6** to allow an automatic supply and/or interruption of the liquid nutrient delivered to the mist nozzles **7**.

[0066] Whilst not shown, the system of **FIG. 1a** may further comprise an inverter and solar panels, for power to be provided to the aeroponic system by solar power harvested by the solar panels via the inverter.

[0067] Referring to **FIG. 2**, the planting tower **1** is in the shape of a trapezoid and comprises side boards **3** with one at the front and one at the back, a pair of end boards **12**, and top boards **19**. The side boards **3** may each be formed by a plurality of board pieces, more specifically, four interconnected board pieces of identical size and length, which are detachable from one another. These four board pieces, when interconnected, forms a substantively quadrilateral shape that defines a side board **3**. Moreover, the side boards **3** are configured to be in a slanting position when erected. The pair of end boards **12** are configured to connect to both side boards **3** at both ends of the planting tower **1**. The top boards **19** are configured to be located on a top of the side boards **3** and the pair of end boards **12**, with the top boards **19** being connected with the end boards **12** together.

[0068] With reference to **FIG. 2**, on every side board **3** and top board **19**, there are planting holes **4** therealong in a matrix-like arrangement. Within each planting hole **4** there is a culture medium **5**, and the planting holes **4** are connected to the space within the planting tower **1**. The planting holes **4** are each shaped in the form of a slanted cylindrical structure, with the culture mediums **5** to be placed in the planting holes **4**.

[0069] Referring to **FIG. 1b**, an embodiment of the aeroponic planting system installed in a traditional greenhouse or containerised greenhouse **104** is shown. This embodiment is to similarly include all of the aforementioned items already described beforehand for the aeroponic planting system for installation in an open space shown in **FIGS 1a** and **2**. Besides them, to control the temperature and humidity within the traditional greenhouse or containerised greenhouse, the embodiment of the aeroponic planting system as shown in **FIG. 1b** further comprises ventilation dampers **101**, ventilation fans **102**, and heaters **103**, which are connected to the controller **27**. With this, an automated control of the ventilation dampers **101**, ventilation fans **102** and heaters **103** is achieved via the controller **27** using a second combined humidity and temperature sensor **28** located within the traditional greenhouse or containerised greenhouse **104** and outside of the planting towers **1**.

[0070] With reference to **FIG. 1b**, the ventilation fans **102** are to switch on automatically when the temperature within the traditional greenhouse or containerised greenhouse **104** reaches a pre-set high temperature. Moreover, the ventilation fans **102** are to switch off automatically when the temperature within the traditional greenhouse or containerised greenhouse **104** reaches a pre-set low temperature level.

[0071] With reference to **FIG. 1b**, the ventilation dampers **101** are to open automatically when the temperature within the traditional greenhouse or containerised greenhouse **104** reaches the pre-set high temperature. Moreover, the ventilation dampers **101** are to close automatically when the temperature within the traditional greenhouse or containerised greenhouse **104** reaches the pre-set low temperature level.

[0072] With reference to **FIG. 1b**, the heaters **103** are to switch on automatically when the temperature within the traditional greenhouse or containerised greenhouse **104** reaches the pre-set low temperature. Moreover, the heaters **103** are to switch off automatically when the temperature within the traditional greenhouse or containerised greenhouse **104** reaches the pre-set high temperature level.

[0073] With reference to **FIG. 1b**, the embodiment of the aeroponic planting system installed in the traditional greenhouse or containerised greenhouse **104** may further comprise gas equipment and at least one gas sensor in the form of CO_2 equipment **105** and CO_2 sensor **106**. The CO_2 equipment **105** may be, by way of example, a CO_2 generator in the case of a large-size greenhouse, or CO_2 cylinders with an automatic solenoid valve coupled with a flowmeter regulator in the case of a small-size greenhouse. The CO_2 equipment **105** automatically activates to supply CO_2 into the traditional greenhouse or containerised greenhouse **104** when the CO_2 concentration level within the traditional greenhouse or containerised greenhouse **104** drops to a pre-set low CO_2 concentration level as measured by the CO_2 sensor **106**. The CO_2 equipment **105** automatically deactivates to stop the supply of CO_2 into the traditional greenhouse or containerised greenhouse **104** when the CO_2 concentration level within the traditional greenhouse or containerised greenhouse **104** reaches a pre-set high CO_2 concentration level as measured by the CO_2 sensor **106**.

[0074] With reference to **FIG. 1b**, the system may further comprise an inverter **100** and solar panels **29**, for power to be provided to the aeroponic system by solar power harvested by the solar panels **29** via the inverter **100**.

[0075] FIG. 3a illustrates a 3-dimensional drawing of a collapsible unit in a partially-folded condition. One or more of these collapsible units may form a containerised greenhouse.

[0076] With reference to **FIG. 3a**, the collapsible unit that forms the containerised greenhouse has square metallic rigid vertical poles that include a set of two rear vertical poles **130**, **131** and a set of two front vertical poles **132**, **133**.

[0077] With reference to **FIG. 3a**, the collapsible unit that forms the containerised greenhouse further has square rigid beams that includes a set of rear beams **136**, **137**, with a first rear beam **136** rigidly connected between top ends of the rear metallic vertical poles **130**, **131**, and a second rear beam **137** rigidly connected between bottom ends of the rear metallic vertical poles **130**, **131**. Furthermore, the collapsible unit further has a set of front beams **138**, **139**, with a first front beam **138** rigidly connected between top ends of the rear vertical poles **132**, **133**, and a second front beam **139** rigidly connected between bottom ends of the rear vertical poles **132**, **133**.

[0078] With reference to **FIG. 3a**, the collapsible unit that forms the containerised greenhouse further has one or more first foldable square metallic cross beams **134**, with one of them being in a hinged connection with top ends of the front vertical pole **132** and the rear vertical pole **130**, and the other being in a hinged connection with the bottom ends of the front vertical pole **132** and the rear vertical pole **130**.

[0079] With reference to **FIG. 3a**, the collapsible unit that forms the containerised greenhouse further has one or more second foldable square metallic cross beams **135**, with one of them being in a hinged connection with top ends of the front vertical pole **133** and the rear vertical pole **131**, and the other being in a hinged connection with the bottom ends of the front vertical pole **133** and the rear vertical pole **131**.

[0080] With reference to **FIG. 3a**, the collapsible unit that forms the containerised greenhouse further has a first metallic frame that holds in place a rear board **140**. This said metallic frame is in a rigid connection between the rear vertical poles **130**, **131**. The rear board **140** is made of material that can transmit light, which may be, by way of example, polycarbonate.

[0081]. With reference to **FIG. 3a**, the collapsible unit that forms the containerised greenhouse further has a second metallic frame that holds in place a ceiling board **141**. This said metallic frame is in a hinged connection with a top side of the first rear beam **136** of the

rear beams **136**, **137**. The ceiling board **141** is made of material that can transmit light , which may be, by way of example, polycarbonate.

[0082] With reference to **FIG. 3a**, the collapsible unit that forms the containerised greenhouse further has a floor board **142** that is in a hinged connection with a bottom side of the second rear beam **137** of the rear beams **136**, **137**. In particular, the floor board **142** forms the floor of the collapsible unit, and eventually, the floor of the containerised greenhouse, especially when the floor board **142** is lowered down to be flat against the ground.

[0083] With reference to **FIG. 3a**, the collapsible unit that forms the containerised greenhouse further has a third metallic frame that holds in place a front door **143**. This said metallic frame is in a hinged connection with an inner side of a first rear vertical pole **130** of the rear vertical poles **130**, **131**. The front door **143** is made of material that can transmit light, which may be, by way of example, polycarbonate.

[0084] With reference to **FIG. 3a**, the collapsible unit that forms the containerised greenhouse further has a fourth metallic frame that holds in place a back door **144**. This said metallic frame is in a hinged connection with an inner side of a second rear vertical pole **131** of the rear vertical poles **130**, **131**. The back door **144** is made of material that can transmit light, which may be, by way of example, polycarbonate.

[0085] With reference to **FIG. 3a**, the collapsible unit that forms the containerised greenhouse further has a fifth metallic frame that holds in place a front board **146**. This said metallic frame is in a rigid connection between the front vertical poles **132**, **133** at their inner sides. The front board **146** is made of material that can transmit light , which may be, by way of example, polycarbonate.

[0086] **FIG. 3b** illustrates the containerised greenhouse that is formed by one or more collapsible units as shown in **FIG. 3a**, wherein the erected collapsible units are connected together for forming the containerised greenhouse. With this, there is a larger planting area.

[0087] With reference to **FIG. 3b**, when forming the containerised greenhouse using the one or more collapsible units, the collapsible units that are in connection with another are to

have their doors **143**, **144** removed at areas of the said connection. Only the collapsible units located at the distal ends of the containerised greenhouse are to have their front door **143** or the back door **144** remain or retained.

[0088] With reference to **FIG. 3b**, when forming the containerised greenhouse using the one or more collapsible units, the collapsible units that are in connection with another are to have their front boards **146** removed at areas of the said connection. Only the collapsible units located at lateral distal ends of the containerised greenhouse are to have their front boards **146** remain or retained.

[0089] FIG. 4 shows the controllable functions of the controller **27** For providing automation of the aeroponic planting system. More specifically, an example home page screen of the controller **27** of the present invention.

[0090] Preferably, the controller **27** controls the operation of any one or a combination of a water supply inlet line, a fertiliser replenishment line, and a nutrient liquid distribution line.

[0091] In particular, the water inlet line includes the solenoid valve **14** at the water supply inlet. The solenoid valve **14** is controlled by controller **27**. The controller **27** controls the solenoid valve **14** to open automatically when the level of the nutrient liquid inside the nutrient liquid distribution tank **24** reaches the pre-set low level. Moreover, the controller **27** controls the solenoid valve **14** to close automatically when the level of the nutrient liquid inside the nutrient liquid distribution tank **24** reaches the pre-set high level.

[0092] In particular, the fertiliser replenishment line includes the replenishment pump **23**, a fertiliser mixer, and a level switch of the fertiliser tank **25**. The replenishment pump is controlled by controller **27**. The controller **27** controls the replenishment pump **23** to automatically start pumping fertiliser from the fertiliser tank **25** to the nutrient liquid distribution tank **24** when the nutrient liquid in the nutrient liquid distribution tank **24** reaches a pre-set low level. Moreover, the controller **27** controls the replenishment pump **23** to automatically stop pumping fertiliser from the fertiliser tank **25** to the nutrient liquid distribution tank **24** when the fertiliser in the fertiliser tank **25** reaches a pre-set low level, and at the same time, the controller **27** may further control one or more alarms to alert this

low level by alerting in a visual and/or audible manner. The fertiliser mixer is manually operated.

[0093] In particular, the nutrient liquid distribution line includes the nutrient liquid distribution pump **10**, the first combined temperature and humidity sensor **26**, distribution solenoid valves **17**, a nutrient liquid mixer, and a level switch of the nutrient liquid distribution tank **24**, and ancillary sensors for monitoring of the electrical conductivity (EC) and pH values of the nutrient liquid.

[0094] The controller **27** controls the nutrient liquid distribution pump **10** to at least provide two types of nutrient liquid dispensing, which include a proportional fertilisation dispensing and an EC fertilisation dispensing.

[0095] In the case where proportional fertilisation dispensing is selected at the controller **27**, the controller **27** controls the nutrient liquid distribution pump **10** to provide proportional fertilisation dispensing. In particular, a fertiliser input value is automatically generated according to a set water-fertilizer ratio. When the amount of water inflow and the fertiliser input value reaches the set water-fertilizer ratio, the nutrient liquid distribution pump **10** automatically stops dispensing nutrient liquid.

[0096] In the case where EC fertilisation dispensing is selected at the controller **27**, the controller **27** controls the nutrient liquid distribution pump **10** to provide EC fertilisation dispensing. In particular, an inlet water volume value is automatically generated according to the volume of the nutrient liquid distribution tank **24** and a pre-set EC value. When both the inlet water volume value and the pre-set EC value are reached, the nutrient liquid distribution pump **10** automatically stops dispensing nutrient liquid.

[0097] With reference to **FIG. 4**, the controllable functions of the controller **27** further include temperature and humidity control settings for the planting towers **1**. This said control setting may be a separate control setting. This said control settings is to enable input settings of a temperature upper limit, a temperature lower limit, a humidity upper limit, and a humidity lower limit. These said settings provide a choice to the user on whether or not to perform a temperature control and/or a humidity control for the planting towers **1**.

[0098] Regarding the temperature lower limit of the temperature and humidity control setting, it is to be a threshold in which the controller **27** refers to for automatically closing the distribution solenoid valves **17** when the temperature is lower than this said threshold.

[0099] Regarding the temperature upper limit of the temperature and humidity control setting, it is to be a threshold where in which the controller **27** refers to for automatically opening the distribution solenoid valves **17** for their continued operation when the temperature rises and reaches this said threshold. This enables the distribution solenoid valves **17** to reopen after they have been closed.

[00100] Regarding the humidity upper limit of the temperature and humidity control setting, it is to be a threshold in which the controller **27** refers to for automatically closing the distribution solenoid valves **17** when the humidity reaches this said threshold.

[00101] Regarding the humidity lower limit of the temperature and humidity control setting, it is to be a threshold where in which the controller **27** refers to for automatically opening the distribution solenoid valves **17** for their continued operation when the humidity drops and reaches this said threshold. This enables the distribution solenoid valves **17** to reopen after they have been closed.

[00102] Regarding the temperature and humidity control setting, in the case where there is a combined switch for the both temperature and control humidity setting in an actuated state, the distribution solenoid valves **17** are opened and closed according to the set values. Alternatively, in the case where there are two switches for the temperature setting and the humidity setting, the distribution solenoid valves **17** are opened and closed when the set values of the temperature and humidity conditions are reached.

[00103] With reference to **FIG. 4**, the controllable functions of the controller **27** further include irrigation settings for the planting towers **1**. There are 16 sets of irrigation programs, with each set of irrigation program having a start time and stop time.

[00104] In particular, the irrigation settings include inputs for irrigation time, for setting an irrigation start time and an irrigation stop time.

[00105] In particular, the irrigation settings include inputs for valve selection, for selecting distribution solenoid valves **17** that are required for irrigation.

[00106]With reference to **FIG. 4**, the controllable functions of the controller **27** further include liquid level settings. The liquid level settings include an upper limit of a nutrient liquid level at an inlet of the nutrient liquid distribution tank **24**, a lower limit of a nutrient liquid level at the inlet of the liquid distribution tank **24**, an upper limit of a nutrient liquid level at an outlet of the nutrient liquid distribution tank **24**, a lower limit of a nutrient liquid level at the outlet of the nutrient liquid distribution tank **24**, an upper limit of a nutrient liquid level at an outlet of the fertiliser tank **25**, and a lower limit of a nutrient liquid level at the outlet of the fertiliser tank **25**,

[00107] Regarding the upper limit of a nutrient liquid level at the inlet of the nutrient liquid distribution tank **24**, it is to be a threshold in which the controller **27** refers to for automatically stopping operation of the solenoid valve **14** at the water supply inlet, the nutrient liquid distribution pump **10**, and the return flow pump **15** when this threshold is reached. At this said threshold, the nutrient liquid distribution tank **24** may not be further filled with water. Moreover, when this threshold is reached, the controller **27** may further activate a high water level alarm to alert the surroundings.

[00108] Regarding the lower limit of a nutrient liquid level at the inlet of the nutrient liquid distribution tank **24**, it is to be a threshold in which the controller **27** refers to for deactivating an activated high water level alarm when the water level of the nutrient liquid distribution tank **24** falls below the said threshold.

[00109] Regarding the lower limit of a nutrient liquid level at the outlet of the nutrient liquid distribution tank **24**, it is to be a threshold in which the controller **27** refers to for automatically stopping operation of the nutrient liquid distribution pump **10** when the tank level of the nutrient liquid distribution tank **24** falls below the said threshold. Moreover, when this threshold is reached, the controller **27** may further activate a low water level alarm to alert the surroundings.

[00110] Regarding the upper limit of a nutrient liquid level at an outlet of the nutrient liquid distribution tank **24**, it is to be a threshold in which the controller **27** refers to for deactivating

an activated low water level alarm when the water level of the nutrient liquid distribution tank **24** rises above the said threshold.

[00111] Regarding the lower limit of a nutrient liquid level at the outlet of the fertiliser tank **25**, it is to be a threshold in which the controller **27** refers to for automatically stopping operation of the replenishment pump **23** when the fertiliser level of the fertiliser tank **25** falls below the said threshold. Moreover, when this threshold is reached, the controller **27** may further activate a low water level alarm to alert the surroundings.

[00112] Regarding the upper limit of a nutrient liquid level at an outlet of the fertiliser tank **25**, it is to be a threshold in which the controller **27** refers to for deactivating an activated low water level alarm when the water level of the fertiliser tank **25** rises above the said threshold.

[00113] Furthermore, the controller controls the operation of a fertiliser replenishment line, which includes the return flow pump **15** and a level switch of the recycled nutrient liquid tank **9**. The controller **27** controls the return flow pump **15** to automatically start pumping nutrient liquid inside the recycled nutrient liquid tank **9** away therefrom when the nutrient liquid level inside the recycled nutrient liquid tank **9** reaches a pre-set high level. Preferably, the nutrient liquid that is dripped onto the base tray **2** of the planting towers **1** is drained from the base tray **2** by gravity. Moreover, the controller **27** controls the return flow pump **15** to automatically stop when the nutrient liquid level in the recycled nutrient liquid tank **9** reaches a pre-set low level.

[00114] Furthermore, the controller **27** controls the operation of one or more pieces of equipment for controlling the climate within the traditional greenhouse or containerised greenhouse **104**.

[00115] In particular, the equipment controlled by the controller **27** includes the ventilation fans **102**. The controller **27** controls the ventilation fans **102** to automatically turn on when the temperature within the traditional greenhouse or containerised greenhouse **104** reaches a pre-set high temperature. Moreover, the controller **27** controls the ventilation fans **102** to automatically turn off when the temperature within the traditional greenhouse or containerised greenhouse **104** reaches a pre-set low temperature.

[00116] In particular, the equipment controlled by the controller **27** further includes the ventilation dampers **101**. The controller **27** controls the ventilation dampers **101** to automatically open when the temperature within the traditional greenhouse or containerised greenhouse **104** reaches a pre-set high temperature. Moreover, the controller **27** controls the ventilation dampers **101** to automatically close when the temperature within the traditional greenhouse or containerised greenhouse **104** reaches a pre-set low temperature.

[00117] In particular, the equipment controlled by the controller **27** further includes the heaters **103**. The controller **27** controls the heaters **103** to automatically switch on when the temperature within the traditional greenhouse or containerised greenhouse **104** reaches a pre-set low temperature. Moreover, the controller **27** controls the heaters **103** to automatically switch off when the temperature within the traditional greenhouse or containerised greenhouse **104** reaches a pre-set high temperature.

[00118] Furthermore, the equipment controlled by the controller **27** further in gas equipment and in the form of CO_2 equipment **105** and CO_2 sensor **106**. The CO_2 equipment **105** may be, by way of example, a CO_2 generator in the case of a large-size greenhouse, or CO_2 cylinders with an automatic solenoid valve coupled with a flowmeter regulator in the case of a small-size greenhouse. The CO_2 equipment **105 is** automatically activated by the controller **27** to supply CO_2 into the traditional greenhouse or containerised greenhouse **104** when the CO_2 concentration level within the traditional greenhouse or containerised greenhouse **104** drops to a pre-set low CO_2 concentration level as measured by the CO_2 sensor **106**. The CO_2 equipment **105 is** automatically deactivated by the controller **27** to stop supply of CO_2 into the traditional greenhouse or containerised greenhouse **104** when the CO_2 concentration level within the traditional greenhouse or containerised greenhouse **104** reaches a pre-set high CO_2 concentration level as measured by the CO_2 sensor **106**.

[00119] FIG. 5 illustrates an automatic seed-sowing device used in the present invention, which comprises a sponge storage container **31**, an unsown sponge conveyor **32**, a sown sponge conveyor **33**, a limiter cylinder for sowing, a vacuum device **35** that is movable in one or more direction for moving in a left and/or right direction and for performing a raising action and/or a lowering action, a seed tray **36**, a vibrating device **37** for the seed tray **36**, a perforated panel **38** which can be raised and lowered, and a cabinet **30**.

[00120] With reference to **FIG. 5**, the sown sponge conveyor **33** and the unsown sponge conveyor **32** are installed on top of cabinet **30**. There are further small pneumatic cylinders **34** that are installed on the sides of the sown sponge conveyor **33** and the unsown sponge conveyor **32**. Furthermore, the unsown sponge conveyor **32** is installed with the sponge storage container **31** at its top.

[00121] With reference to **FIG. 5**, there are two frames connected to the top of the cabinet **30**, with each frame installed with four pneumatic cylinders at its sides. In particular, two of these pneumatic cylinders are to control side movements of the vacuum device **35** and the lifting and/or lowering of the vacuum device **35**. In particular, the other two pneumatic cylinders are to control the lifting and/or lowering of the perforated panel **38**.

[00122] With reference to **FIG. 5**, the perforated panel **38** is installed with one or more conical tubes on its external surface.

[00123] With reference to **FIG. 5**, the vacuum device **35** is installed with one or more needle-shaped suction nozzles installed thereon.

[00124] With reference to **FIG. 5**, the sown sponge conveyor **33** is installed with the seed tray **33** and the seed tray vibrating device **37**.

[00125] The operation of the automatic seed-sowing device shown in **FIG. 5** may comprise one or more steps.

[00126] In a first step, the sponge storage container **31** is filled up with sponge pieces **39**.

[00127] Next, in a second step, the unsown sponge conveyor **32** is activated to automatically turn one round and stop thereafter.

[00128] Next, in a third step, the unsown sponge conveyor **32** begins to operate and transports the sponge piece **39** at the bottom of the sponge storage container **31** to a preset position below the perforated panel **38**.

[00129] Next, in a fourth step, when sponge piece **39** reaches the preset position, two small pneumatic cylinders **34** on each side limit the position of the sponge piece **39**.

[00130] Next, in a fifth step, after determining by a detection device that the sponge piece **39** is present, the unsown sponge conveyor **32** stops its automatic operation.

[00131] Next, in a sixth step, the vacuum device **35** moves to position itself above the seed tray **36** and lowers itself to suck the seeds, and at the same time, the seed tray vibrating device **37** begins vibrating to make it easier for the needle-shaped suction nozzles of the vacuum device **35** to suck the seeds.

[00132] Next, in a seventh step, the vacuum device **35**, having seeds sucked in its needle-shaped suction nozzles, moves automatically back to above the perforated panel **38**.

[00133] Next, in an eighth step, the perforated panel **38** automatically moves downwards to be just above the sponge piece **39**, which was positioned at the said location earlier on the unsown sponge conveyor **32**. Preferably, during this step, the conical tubes of the perforated panel **38** coincide exactly with the positions of all the pre-cut round cubes of the sponge piece **39** below, widening up the hole of each pre-cut round cube. Preferably, during this step, the vacuum device **35** above the perforated panel **38** lowers itself to allow its needle-shaped suction nozzles to match all the conical tubes of the perforated panel **38**.

[00134] Next, in a ninth step, the vacuum device **35** stops operating, thereby allowing the seeds which are sucked by the needle-shaped suction nozzles to drop into the enlarged holes of the all the pre-cut round cubes on the sponge piece **39**.

[00135] Next, in a tenth step, after the seeds are dropped, the vacuum device **35** automatically moves upwards back to its original position.

[00136] Next, in an eleventh step, the perforated panel **38** moves back to its original position as well.

[00137] Next, in a twelfth step, the small pneumatic cylinders **34** on the sides release the limiting of the positions.

[00138] Next, in a thirteenth step, the sown sponge conveyor **33** starts to operate to transport the sponge piece **39**, which had been sown with seeds, to its next position.

[00139] Finally, in a fourteenth step, after the sponge piece **39**, which had been sown with seeds, is transported out. At the same time, the present piece of sponge piece **39** at the bottom of the sponge storage container **31** is transported to the preset position that is below the perforated panel **38**, and the two small pneumatic cylinders **34** on each side once again limit the position of the sponge piece **39**. With this, the automatic seed-sowing device continues its operation and repeats the above sequence of steps.

[00140] FIG. 6 and **FIG. 7** illustrates an automatic seedling-transferring device **40** used in the present invention, which comprises a traverse manipulator module **41**, a vertical manipulator module **42**, and a separation manipulator module **43**. The automatic seedling-transferring device **40** is further installed with a first conveyor for the sponge piece and a second conveyor for the planting boards. In particular, each conveyor is installed with sensor(s) at their respective end positions.

[00141] With reference to **FIG. 6** and **FIG. 7**, the separation manipulator **43** is incorporated with one or more grippers **44** and a servo motor screw structure **45**. Preferably, there are five grippers **44**.

[00142] The operation of the automatic seedling-transferring device **40 is** shown in **FIG. 6** and **FIG. 7** may comprise one or more steps.

[00143] In a first step, a complete sponge piece that has been pre-cut into one or more round sponge pieces **46** is transported on the first conveyor, while the side boards **3** are transported on the second conveyor. Alternatively, depending on actual requirements, the top boards **19** may be transported on the second conveyor. In particular, the complete sponge piece has dimensions of 250 mm x 250 mm, and is pre-cut into 9 rows of 81 pieces of round sponge pieces **46**.

[00144] Next, in a second step, when the first conveyor transporting the round sponge pieces **46** and the second conveyor transporting the side boards **3** (or top boards **19**) reach their

respective pre-set positions as sensed by a sensor, both the first conveyor and the second conveyor stop their operation.

[00145] Next, in a third step, a signal is sent out by the sensor that is received by the programmable controller of the automatic seedling-transferring device **40** for the said programmable controller to direct the traverse manipulator module **41**, the vertical manipulator module **42**, and the separation manipulator **43** to move towards the location of the round sponge pieces **46**.

[00146] Finally, in a fourth step, the grippers of the separation manipulator **43** as controlled by the servo motor screw structure **45**, move towards a round sponge piece to grip said round sponge piece for correspondingly inserting it into one designated planting hole of the side boards **3** (or top boards **19**).

[00147] In particular, in the fourth step, each of the grippers **44** is spaced between each other in a manner that is similar to the spacing between the round sponge pieces **46**.

[00148] In particular as well, in the fourth step, the diameter of each of the round sponge pieces **46** is 21 mm, while the diameter of the planting holes of the side boards **3** (or top board **19**) is 20 mm, hence the grippers **44** are to further compress the round sponge piece gripped therein for reducing the diameter of the round sponge piece so that it can be correspondingly inserting it into one designated planting hole of the side boards **3** (or top boards **19**).

[00149] In particular as well, in the fourth step, since the spacing between planting holes of the side board **3** and the spacing between planting holes of the top boards **19** are different, in order to accommodate the actual requirements, the servo motor screw structure **45** of the separation manipulator **43** may further adjust the spacing of the grippers **44** to be in accordance with the actual spacing of the side boards **3** or top boards **19**. This will ensure that the round sponge pieces are inserted into the planting holes of the side boards **3** or top boards **19** accurately.

[00150] **FIGS 8** to **11** illustrate a placement system used in the present invention, which includes an automatic placement-collection mechanism, and a machine-assisted placement device.

[00151] **FIGS 8** to **11** illustrate an automatic placement-collection mechanism used in the present invention, which comprises a compound automated guided vehicle **60**, a robotic arm **61**, a robotic arm gripper **62**, and a transport rack **63**. The automatic placement-collection mechanism is to automatically place and/or collect the side boards **3** and top boards **19**.

[00152] In particular, the compound automated guided vehicle **60** is installed with a visualizer, and the transport rack **63** is installed with a drawbar **71**. Moreover, both the side boards **3** and the top boards **19** are to be incorporated with hooking holes **64**, and the external sides of these boards **3**, **19** are to be also incorporated with groove **65**. The robotic arm **61** is installed on the compound automated guided vehicle **60**, and the robotic arm **61** is installed with gripper **62** at its end.

[00153] In particular, the compound automated guided vehicle **60** can be an automated guided vehicle (AGV), and employs a fully automated and intelligent operation. Moreover, through a control program, it is capable of a continuous 24-hour operation, which is suitable for large farms.

[00154] In particular, the compound automated guided vehicle **60**, through its installed visualiser and pre-set program, may be operated to perform one or more steps for collecting and transporting side boards **3** of a planting tower **1**.

[00155] In a first step, the compound automated guided vehicle **60**, having an empty transport rack **63** connected to its drawbar **71** drives autonomously to a pre-selected growing tower **1** with the aid of a bar code reader attached to the compound automated guided vehicle **60** for reading a particular bar code that is attached to each planting tower **1**.

[00156] Next, in a second step, the robotic arm **61** of the compound automated guided vehicle **60** moves towards a selected side board **3** that has grown vegetables.

[00157] Next, in a third step, the gripper **62** of the robotic arm **61** grips a board piece of the selected side board **3**, more specifically, the grooves **65** on both sides of the board piece of the side board **3**, and places each board piece of side board **3**, piece by piece, onto the currently empty transport rack **63**. In particular, the side boards **3** are each placed on the transport rack **63** from its bottom to its top, until the transport rack **63** is fully stacked with side boards **3** with grown vegetables.

[00158] Next, in a fourth step, when the transport rack **63** is full, the compound automated guided vehicle **60** drives autonomously to the vegetable root-cutting area for discharging all of its side boards **3** with grown vegetables thereto.

[00159] Finally, in a fifth step, the compound automated guided vehicle **60**, now having an empty transport rack **63**, drives back to a location where the last piece of side board **3** was collected with the aid of the bar code reader attached to the compound automated guided vehicle **60** for reading the particular bar code that is attached to each planting tower **1**, to continue with its collection work. With this, the compound automated guided vehicle **60** continues its operation and repeats the above sequence of steps until all side boards **3** at the front and back of the planting tower **1** are collected and transported to the vegetable root-cutting area, where the side boards **3** having grown vegetables are unloaded thereto.

[00160] In particular, the compound automated guided vehicle **60**, through its installed visualiser and pre-set program, may be operated to perform one or more steps for collecting and transporting top boards **19** of a planting tower **1**.

[00161] In a first step, the compound automated guided vehicle **60**, having an empty transport rack **63** connected onto its drawbar **71** drives autonomously to a pre-selected growing tower **1**. with the aid of the bar code reader attached to the compound automated guided vehicle **60** for reading a particular bar code that is attached to each planting tower **1**.

[00162] Next, in a second step, the robotic arm **61** of the compound automated guided vehicle **60** moves towards a selected top board **19** that has grown vegetables.

[00163] Next, in a third step, the gripper **62** of the robotic arm **61** grips the selected top board **19**, more specifically, the grooves **65** on both sides of the top board **19**, and places

each top board **19**, piece by piece, onto the transport rack **63** that is currently empty. In particular, the top boards **19** are each placed on the transport rack **63** from its bottom to its top, until the transport rack **63** is fully stacked with top boards **19** with grown vegetables.

[00164] Next, in a fourth step, when the transport rack **63** is full, the compound automated guided vehicle **60** drives autonomously to the vegetable root-cutting area for discharging all of its top boards **19** with grown vegetables thereto.

[00165] Finally, in a fifth step, the compound automated guided vehicle **60**, now having an empty transport rack **63**, drives back to the location where the last piece of top board **19** was collected with the aid of the bar code reader attached to the compound automated guided vehicle **60** in reading the particular bar code that is attached to each planting tower **1**, to continue with its collection work. With this, the compound automated guided vehicle **60** continues its operation and repeats the above sequence of steps until all top boards **19** of the planting tower **1** are collected and transported to the vegetable root-cutting area, where the top boards **19** having grown vegetables are unloaded thereto.

[00166] With reference to **FIGS 8** to **11**, the machine-assisted placement device comprises a vehicle **72**, a vehicle controller **73**, a guardrail **74**, a storage rack **75**, and a hand gripper **76**. The vehicle **72** may be driven by an internal combustion engine or an electrical engine. The vehicle controller **73**, the guardrail **74**, and the storage rack **75** are installed on the vehicle **72**.

[00167] In particular, the machine-assisted placement device is a manually operated semi-automatic device, and may be capable of performing similar functionalities as the compound automated guided vehicle **60** and the robotic arm **61**. Hence, the machine-assisted placement device may replace the automatic equipment such as the compound automated guided vehicle **60** and robotic arm **61**, thereby reducing the overall costs and thus making it suitable for smaller vegetable farms.

[00168] With reference to **FIG. 11,** the vehicle **72** may be operated to perform one or more steps.

[00169] In a first step, an operator drives the vehicle **72**, with its rack **75** loaded with the side boards **3** (or top boards **19**), to a location and a position where the side boards **3** (or top boards **19**) are to be placed onto the planting tower **1**.

[00170] Next, in a second step, the operator in vehicle **72** uses a hand gripper **76** to grip onto grooves **65** of the side boards **3** (or top boards **19**) having seedlings grown thereon, for removing the side boards **3** (or top boards **19**) from the storage rack **75** and placing the side boards **3** (or top boards **19**) onto the planting tower **1**. In particular, the placement of the side boards **3** (or top boards **19**) onto the planting tower **1** involves placing the two hooking holes **64** of each side board **3** (or top board **19**) onto two corresponding holding studs for each piece of the side board **3** (or top board **19**). The aforementioned holding studs may be fitted on leg supports of the planting tower **1** (in the case for side boards **3**), or fitted on the top bar of the planting tower **1** (in the case for top boards **19**).

[00171] Next, in a third step, the vehicle **72** is made to continue its placement of all the side boards **3** (or top boards **19**) onto the planting tower **1**.

[00172] Next, in a fourth step, by use of the vehicle controller **73**, the operator drives vehicle **72** to a nursery area to load the other side boards **3** (or top boards **19**) that are grown with seedlings, thereonto, until the storage rack **75** is fully stacked up.

[00173] Finally, in a fourth step, the vehicle **72** is driven back to the area where side boards **3** (or top boards **19**) was previously placed. With this, the vehicle **72** continues its operation and repeats the above sequence of steps.

[00174] **FIGS 12** and **13** illustrate an automatic root-cutting device used in the present invention, which comprises a cutting table **80**, a mounting port **82** for the side boards **3** (or top boards **19**), an automatic clamp **83** for the boards **3**, **19**, a pneumatic cylinder **84**, a cutter **85**, a container **86** for vegetable roots, one or more limit switches **87**, and an air compressor **81**.

[00175] With reference to **FIGS 12** and **13**, the cutting table **80** is incorporated at the middle of the top of the automatic root-cutting device, and it has the mounting port **82** for the side boards **3** (or top boards **19**). Furthermore, the cutting table **80** is installed with the automatic

clamp **83** at the side of the cutting table **80**. Furthermore, the cutting table **80** is installed with the pneumatic cylinder **84** at the top right side of the cutting table **80** and the cutter **85** at the top the cutting table **80**. Furthermore, the cutting table **80** is installed with two limit switches **87**, with a first limit switch installed and located on the top left end of the cutting table **80**, and a second limit switch installed and located next to the automatic clamp **80**. Furthermore, the cutting table **80** is installed with the air compressor **81** being below the cutting table **80**, with the air compressor **81** being installed at a mounting of the cutting table **80**.

[00176] With reference to **FIGS 12** and **13**, the automatic root-cutting device further has a control system involving a solenoid valve (not shown) and the air compressor. The solenoid valve that is in electrical connection with the automatic clamp **83**, the limit switches **87**, and the pneumatic cylinder **84**, and the air compressor **81** supply compressed air to the pneumatic cylinder **84**.

[00177] In particular, the automatic root-cutting device may be operated to perform one or more steps for cutting roots of the grown vegetables on the boards **3**, **19**.

[00178] In particular, prior to operation of the automatic root-cutting device, its pneumatic cylinder **84** is in an initial position, with its arm in a contracted state.

[00179] In a first step, a side board **3** (or top board **19**) with grown vegetables are placed onto the mounting port **82**. The step may be done manually.

[00180] Next, in a second step, the limit switch **87** energises the automatic clamp **83** and the pneumatic cylinder **84**. More specifically, as the side board **3** (or top board **19**) is placed onto the mounting port **82** as per the previous step, the limit switch **87** adjacent to the mounting port **82** contacts due to side board **3** (or top board **19**) on the mounting port **82**, and causes the solenoid valve to energise the automatic clamp **83** to hold the side board **3** (or top board **19**) on the mounting port **82**. At the same time, the solenoid valve energises the pneumatic cylinder **84** to extend its cylinder arm outwardly to push the side board **3** (or top board **19**) with the grown vegetables towards the cutter **85**.

[00181] Next, in a fourth step, as the side board **3** (or top board **19**) is pushed by pneumatic cylinder **84**, the roots of the vegetables on the side board **3** (or top board **19**) are cut by the cutter **85**, and the cut vegetable roots drop into the container **86** that holds the cut vegetable roots. The container **86** is to facilitate disposal of the cut vegetable roots later on.

[00182] Next, in a fifth step, the side board **3** (or top board **19**) reaches the other limit switch **87** located at the other end of the cutting table **80**, and becomes in contact with the said limit switch **87**.

[00183] Next, in a sixth step, the other limit switch **87** located at the other end of the cutting table **80** de-energises the automatic clamp **83** and stops further movement of the pneumatic cylinder **84**. With this, the automatic clamp **83** is opened for release of the side board **3** (or top board **19**).

[00184] Finally, in a seventh step, the side board **3** (or top board **19**), now having grown vegetables with cut roots, is removed from the mounting port **82**. With this, the limit switch **87** that is adjacent to the mounting port **82** returns to its original state, and the said solenoid valve de-energises the pneumatic cylinder **84**. More specifically, the said solenoid valve de-energises the pneumatic cylinder **84** by stopping supply of compressed air thereto, so that its cylinder arm is brought back to its original contracted position. With this, the operation of the automatic root-cutting device is deemed complete, and the above sequence of steps may repeat upon receipt of a subsequent side board **3** (or top board **19**) having grown vegetables with uncut roots.

[00185] **FIG 14** illustrates an automatic vegetable-packing device used in the present invention, which comprises a vegetable conveyor **90**, a packaging unit **91**, and a delivery unit **92**.

[00186] With reference to **FIG. 14**, the vegetable conveyor **90** is installed and in connection with the packaging unit **91**. The packaging unit **91** includes a motor, a drive roller, a packaging film, a feed conveyor, and a shaper. Furthermore, the vegetable conveyor **90** is installed with the delivery unit **92** at the end of the right side of the vegetable conveyor **90**. The delivery unit **92** is to work in conjunction with the packaging unit **91**.

[00187] In particular, the automatic vegetable-packing device may be operated to perform one or more steps for packing vegetables.

[00188] In a first step, the vegetables with cut roots are placed onto the vegetable conveyor **90** and are transported into the packaging unit **91**.

[00189] Next, in a second step, within the packaging unit **91**, its drive roller, which is driven by its motor, delivers the packaging film to package the vegetables for them to become packed vegetables.

[00190] Next, in a third step, the packed vegetables are delivered by the feed conveyor of the packaging unit **91** to the shaper, so that the packed vegetables are shaped, sealed up, longitudinally sealed, and transversely cut. and sent to the delivery unit **92** as end products.

[00191] Finally, in a fourth step, the packed vegetables are sent from the packaging unit **91** to the delivery unit **92** as end products. With this, the operation of the automatic vegetable-packing device is deemed complete, and the above sequence of steps may repeat upon receipt of subsequent grown vegetables with cut roots.

[00192] The characteristics and functions of this invention are further appreciated from the following description.

[00193] The embodiments of the present invention show an aeroponic planting system that operates in an automated manner, which comprises a recycled nutrient liquid tank **9**, at least one planting tower **1** for planting plants that has at least one set of independent and identical planting boards that includes side boards **3** and top boards **19**, a base tray **2** on a tray support **13** that separates the recycled nutrient liquid tank **9** and the planting tower **1**, and a mist device for providing nutrient liquid to the plants planted on the planting tower **1**.

[00194] In particular, the planting tower **1** comprises side boards **3**, a pair of end boards **12** connected to the side boards **3**, a top board **19** connected to the side boards **3** at the top of the side boards **3** and a plurality of planting holes **4** are incorporated on the side boards **3** and top board **19**.

[00195] In particular, within each planting hole **4** there is a culture medium **5**. Furthermore, the side boards **3**, the top board **19** and the end boards **12** are connected by connecting bars, with at least two through holes **121** provided on end boards **12**. The mist device includes a nutrient liquid distribution pump **10**, an outlet of nutrient liquid pump **10** that is connected to outlet pipe **8**, a liquid filter **20** that is connected to the outlet pipe **8**, a strong magnetic processor **21** that is connected with the outlet pipe **8**. Moreover, the outlet pipe **8** penetrates through the holes **121** at both left and right end boards **12** to be in connection with the branch pipes **6** that are installed with mist nozzles **7**.

[00196] In particular, the structure of the planting tower **1** is formed by side boards **3** and top boards **19**. The side boards **3** are provided with planting holes **4** that are spaced apart from each other, with their vertical spacing along the board **3** being greater than their horizontal spacing along the board **3**. The top boards **19** are provided with planting holes **4**, with their vertical spacing along the board **19** being the same as their horizontal spacing along the board **19**. Furthermore, the planting holes **4** are to be placed with standard-sized seedling growth medium **5**. The growth medium **5** is to have strong water absorption so that the seedlings can absorb the nutrient solution to grow. The growth medium, may be, by way of example, a sponge.

[00197] In particular, the top boards **19**, side boards **3**, end boards **12** and base tray **2** form a closed internal space, with branch pipes **6** conveying nutrient liquid thereinto. The branch pipes are installed with mist nozzles **7**, and each mist nozzle **7** is preferably at a distance away from each other, preferably at a length of at least **250** mm, so that they can provide nutrient liquid in mist form to the seedling planted in the planting holes 4.

[00198] In particular, the nutrient liquid distribution pump **10** is connected to the inlet pipe **18**. The outlet of the nutrient solution pump **10** is connected to the outlet pipe **8**. The outlet pipe **8** is connected to the liquid filter **20** and the strong magnetic processor **21**. The outlet pipe **8** further penetrates through the holes **121** on both left and right end boards **12** to be in connection with the branch pipes **6** located inside the planting tower **1**, with the branch pipes **6** installed with mist nozzles **7**.

[00199] In particular, within the closed space formed by the top boards **19**, side boards **3**, end boards **12**, and on the two rows of branch pipes **6**, there are mist nozzles **7**. The mist nozzles **7** are spaced from each other at a distance of at least 250 mm apart.

[00200] In particular, there are drain pipes **11** that allow excess nutrient liquid to drip down from the mist nozzles **7** onto base tray **2** to flow by gravity into the recycled nutrient liquid tank **9**. There is also a return flow pump 15 that is installed between the piping of the recycled nutrient liquid tank **9** and the nutrient liquid distribution tank **24**, for pumping the collected nutrient liquid from the recycled nutrient liquid tank **9** back to the nutrient liquid distribution tank **24**. There is also a replenishment pump **23** that is installed between the piping of the nutrient liquid distribution tank **24** and the fertiliser tank **25**, for replenishing fertiliser from the fertiliser tank **25** to the nutrient liquid distribution tank **24**. There is also a motorised mixer that is installed on each of the nutrient liquid distribution tank **24** and fertiliser tank **25**, for ensuring proper mixture of the nutrient liquid and the fertiliser.

[00201] In particular, the mist device comprises an inlet pipe **18** that is connected to the inlet of nutrient liquid pump **10**, an outlet pipe **8** that is connected to the outlet of nutrient liquid pump **10**, and mist nozzles **7** that are connected to the branch pipes **6** with the branch pipes **6** penetrating through holes **121** of the end boards **12** and is connected to outlet pipe **8**.

[00202] In particular, there is a solenoid valve **14** installed on the piping between the water supply inlet and the nutrient liquid distribution tank **24**, for allowing an automatic supply and interruption of water supplied by the water supply inlet. Moreover, there are distribution solenoid valves **17** installed on the piping between the branch pipes **6** and the mist nozzles **7**, for allowing an automatic supply and interruption of the liquid nutrient supplied to the mist nozzles 7.

[00203] In particular, there is a controller **27** installed into the system to enable it to provide automatic fertilisation and irrigation, and automatic starting and/or stopping of the nutrient liquid distribution pump **10**. More specifically, the operation of the nutrient liquid distribution pump **10**, as controlled by the controller **27**, is based on the measured humidity and temperature within the enclosed space of the planting tower **1** as monitored by a first sensor **26**. It is noted that the enclosed space is where the roots of the vegetables are located. Furthermore, the controller **27** enables the automatic operation of the ventilation fans,

heaters, and ventilation dampers, in which their controlled operation may be based on the measured humidity and temperature within the greenhouse space as monitored by a second sensor **28**, with the greenhouse space being space of a traditional greenhouse or containerised greenhouse **104** having plants planted therein. It is noted that the first sensor **26** and the second sensor **28** each are a combined temperature and humidity sensor.

[00204] It is to be noted that the design of the planting tower **1** of the automated aeroponic planting system of this embodiment is scientific. Assuming an array of planting towers **1**, as long as there is a passageway of at least 0.6 m between each row of planting towers **1**, and with the two ends of each row of the planting towers **1** that are not planted with vegetables arranged to face an east-west direction, the vegetables in each planting tower **1** will be exposed to sunlight throughout the day.

[00205] It is to be noted that within the present invention, most, if not all the components are modular standard parts producible by moulding processes, wherein these components are precisely connected to form a system. In addition, since the parts are producible by moulding processes, the unit cost is low, the on-site installation time is minimised, and the installation cost is minimised. With this, the present invention can truly realize a promotion of agricultural factory technology.

[00206] It is to be noted that since all components are modular standard parts producible from moulding processes, all seams are ensured to be sealed properly, thus avoiding leakage of nutrient solution. This prevents a wastage of nutrient solution, and prevents damage to the vegetables due to algae growth when the nutrient liquid encounters sunlight.

[00207] It is to be noted that since the system is made up of standardised modules, one or more pre-specified standard size specifications can be made in advance to consider the hydraulic calculations of the pipelines to be installed within the system. All the pumps, pipes, nozzles and other components of the system, especially for irrigation, can be standardised. The system may be assembled according to the relevant pre-specified standard specifications according to the area of the farm. This effectively solves the problem of the need to calculate parameters relating to the modules, such as the flow, pressure, etc., of each and every pump. With this, it is ensured that the amount of nutrient solution satisfies the needs of the entire farm area. As such, problems in existing designs and techniques that include the nutrient

solution pump being too far away from the nutrient solution pool can be circumvented. Moreover, the system of the invention becomes easier, less time-consuming, and cheaper to install.

[00208] It is to be noted that within the present invention, since the remaining nutrient liquid sprayed from the mist nozzles **7** to the vegetable roots returns directly to the recycled nutrient liquid tank **9** by gravity, this solves the problems within existing designs and techniques where a sterilisation device, buffer trench, and buffer wall are required because the nutrient solution pool is far away from the planting area.

[00209] It is to be noted that within the present invention, the remaining nutrient liquid from the misting of the vegetable roots via the mist nozzles **7** is enabled to return directly to the recycled nutrient liquid tank **9** by gravity. Thus, this does away with the need to dig a trench in the ground to allow the remaining nutrient solution to return to a nutrient solution pool. Moreover, this makes it suitable for converting various landscapes for farming, such as farmland, reinforced concrete, asphalt ground, etc. Hence, the present invention is conducive to promoting urban agriculture to solve the aforementioned global problems which include the lack of arable land and rapid urban population growth.

[00210] It is to be noted that within the present invention, its modularity enables its scalability. More specifically, the piping between components can form large systems or small systems according to specific user requirements. Moreover, its automatic control and operation further increase its suitability for large-scale agricultural factories and/or small-scale farmers in cities.

[00211] It is to be noted that within the present invention, the planting holes **4** of the planting boards **3**, **19** are designed to be at an ideal angle that considers the calculation of the sloping of the specific planting boards **3**, **19**. In particular, the planting holes **4** which are formed after the said calculation are to face upward, which conforms to the natural growth of vegetables, and is beneficial to the growth of the vegetables.

[00212] It is to be noted that the present invention effectively solves high power consumption in planting systems caused by a non-stop operation of the nutrient liquid pump

that is as conventionally configured in the prior art. Thus, the nutrient liquid pump within the present invention has a lower operating cost and its premature failure is avoided.

[00213] It is to be noted that the design of the present invention allows it to be used in open areas which are common in tropical countries, as well as traditional greenhouses and containerised greenhouses which can be adopted for use in temperate countries.

[00214] It is to be noted the present invention a high yield of vegetables is obtained while saving on the use of electricity due to the use of solar power harvested from the solar panels.

[00215] It is to be noted the present invention provides an automated solar-powered containerised greenhouse that enables sunlight to be used during growth stages of the vegetables and avoids the required use of artificial light sources (such as LED lights), which is currently the norm in planting in containerised greenhouses. This leads to substantial savings on power consumption, and thus much lower prices of the vegetables that will benefit the consumers. The automated solar-powered containerised greenhouse may be located at areas near customers, such as wet markets and supermarkets, and also in strategic or remote places where the population of the said place does not make it commercially viable to set up large traditional greenhouses.

[00216] It is to be noted the present invention may enable agricultural factories to be built quickly and accurately with lower construction costs, and can be deployed with high efficiency in high-capacity urban farms which are being promoted in more and more cities globally to solve the problem of disruptions in the urban food supply chain, especially after the global lockdowns during COVID-19.

[00217] The present disclosure includes as contained in the appended claims, as well as that of the foregoing description. Although this invention has been described in its preferred form with a degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangements of parts may be resorted to without departing from the scope of the invention.

CLAIMS

1. An aeroponic planting system, comprising

a base tray;

at least one planting tower providing a growing area for plants, which is installed on the base tray;

a nutrient liquid distribution tank storing nutrient liquid;

a mist device that includes

a nutrient liquid distribution pump that is in connection with the nutrient liquid distribution tank; and

mist nozzles that are in substantial connection with the nutrient liquid distribution pump, which spray nutrient liquid to cover roots of the plants that are within an enclosed space of the planting tower;

a first heat and humidity sensor installed within the enclosed space of the planting tower; and

a controller that is interfaced with the first heat and humidity sensor and the mist device;

wherein

the controller provides an automated control of the nutrient liquid distribution pump of the mist device based on the temperature and humidity within the enclosed space of the planting tower as measured by the first heat and humidity sensor.

2. The aeroponic planting system, further comprising

a second heat and humidity sensor installed outside of the planting tower that is interfaced with the controller; and

one or more pieces of equipment that include ventilation dampers, ventilation fans, and heaters that are interfaced with the controller;

wherein the controller further provides an automated control of the nutrient liquid distribution pump of the mist device and the equipment based on the temperature and humidity within the enclosed space of the planting tower and outside of the planting tower as measured by the first heat and humidity sensor and the second heat and humidity sensor.

3. The system according to claim 1 or 2, wherein the planting tower further comprises side boards formed by a plurality of board pieces, end boards, and top boards, wherein

the side boards are in connection with the pair of end boards; and

the top boards are located atop the side boards and end boards, and are in connection therewith them.

4. The system according to claim 3, wherein the side boards and the top boards are formed with planting holes that are each in connection with the enclosed spaced within the planting tower, with each planting hole having culture medium disposed therein.

5. The system according to claim 4, wherein the mist device further comprises

at least one inlet pipe which is connected to an inlet of nutrient liquid distribution pump;

at least one outlet pipe which is connected to the outlet of nutrient liquid distribution pump; and

branch pipes that penetrate through the end boards of the planting tower that provide a connection between the outlet pipe and the mist nozzle.

6. The system according to claim 5, wherein the mist device further comprises a liquid filter and a magnetic processor, which are both installed on the outlet pipe, with the liquid filter located nearer to the nutrient liquid distribution pump compared to the magnetic processor.

7. The system according to claim 1 or 2, further comprising an inverter and solar panels, wherein the solar panels provide power to the system via the inverter using solar energy.

8. The system according to claim 2, further comprising gas equipment and at least one gas sensor that is interfaced with the controller, wherein the controller further provides an automated control of the gas equipment based on gas concentration levels measured by the gas sensor.

9. The system according to claim 3, further comprising a seed-sowing device that operates in an automated manner, which comprises

a sponge storage container;

an unsown sponge conveyor;

a sown sponge conveyor;

a set of pneumatic cylinders installed on the unsown sponge conveyor and sown sponge conveyor;

a limiter cylinder for sowing;

a vacuum device that moves in one or more directions;

a perforated panel that moves in one or more directions;

a seed tray and a vibrating device for the said seed tray that both are installed on the sown sponge conveyor; and

a cabinet in which the unsown sponge conveyor and the sown sponge conveyor are installed thereabove.

10. The system according to claim 9, wherein the pneumatic cylinders of the seed-sowing device controls movements of the vacuum device and movements of the perforated panel.

11. The system according to claim 3, further comprising a seedling-transferring device that operates in an automated manner, which comprises

a traverse manipulator module;

a vertical manipulator module; and

a separation manipulator module having a plurality of grippers and a servo motor screw structure.

12. The system according to claim 11, wherein the seedling-transferring device further comprises

a first conveyor installed with a sponge piece;

a second conveyor to be installed with one board from the side boards or the top boards of the planting tower;

wherein the conveyors each are installed with sensors.

13. The system according to claim 3, further comprising a placement system which comprises

an automatic placement-collection mechanism for placing and collecting boards from the side boards or the top boards of the planting tower, which includes

a compound automated guided vehicle installed with a visualiser and a bar code reader;

a transport rack having a drawbar; and

a robotic arm that has grippers;

and

a machine-assisted placement device, which includes

a vehicle that has an internal combustion engine or an electrical engine;

a controller;

a guardrail;

a storage rack; and

a hand gripper.

14. The system according to claim 3, further comprising an automatic root-cutting device, which comprises

a cutting table;

a mounting port for receiving boards from the side boards or the top boards of the planting tower;

an automatic clamp that is controlled by a solenoid valve for clamping boards from the side boards or the top boards of the planting tower;

a pneumatic cylinder;

a cutter;

a container for vegetable roots;

more than one limit switches; and

an air compressor.

15. The system according to claim 14, wherein the limit switches include

a first limit switch that is installed on a top left end of the cutting table; and

a second limit switch that is installed next to the automatic clamp.

16. The system according to claim 3, further comprising an automatic vegetable-packing device, which comprises

a vegetable conveyor;

a packaging unit that includes a motor, a drive roller, a packaging film, a feed conveyor, and a shaper; and

a delivery unit;

wherein

the packaging unit is installed on top of the vegetable conveyor and connected thereto; and

the delivery unit is installed onto a right end side of the vegetable conveyor, and operates in conjunction with the packaging unit.

17. A collapsible unit for forming a greenhouse having an aeroponic planting system according to claim 2, comprising

rigid poles that include a set of rear poles that comprises a first rear pole and a second rear pole, and a set of front poles;

rigid beams that include a set of rear beams that comprises a first rear beam and a second rear beam, and a set of front beams; and

one or more foldable beams that include first foldable beams and second foldable beams;

wherein

the rear beams each are in a rigid connection between top ends or bottom ends of each rear poles, and the front beams each are in a rigid connection between top ends or bottom ends of each front poles; and

the first foldable beams are in a hinged connection between top ends or bottom ends of each front poles, and the second foldable beams are in a hinged connection between top ends or bottom ends of each rear poles.

18. The unit according to claim 17, further comprising a floor board that is in a hinged connection with a side of the second rear beam, which forms a floor when it is lowered down to assume a flat position.

19. The unit according to claim 17 or 18, further comprising

a first frame that is in a rigid connection with the set of rear poles, which holds in place a rear board;

a second frame that is in a hinged connection with a side of the first rear beam, which holds in place a ceiling board;

a third frame that is in a hinged connection with a side of the first rear pole, which holds in place a front door;

a fourth frame that is in a hinged connection with a side of the second rear pole, which holds in place a back door; and

a fifth frame that is in a rigid connection with sides of the front poles, which holds in place a front board.

20. The unit according to claim 19, wherein the said unit is connectable with units of the same to form a greenhouse, through openings defined by their doors and/or their front boards, wherein

the doors of units located at distal ends of the formed greenhouse are to only remain; and

the front boards of units located at distal ends of the formed greenhouse are to only remain.