A DEVICE FOR GROWING A HORTICULTURAL PRODUCT

Technical Field

[0001] The present disclosure generally relates to agriculture. More particularly, it relates to a device for growing a horticultural product such as a mushroom.

Background

[0002] The following discussion of the background to the invention is intended to facilitate an understanding of the present invention. However, it should be appreciated that the discussion is not an acknowledgment or admission that any of the material referred to was published, known or part of the common general knowledge in any jurisdiction as at the priority date of the application.

[0003] The Covid-19 pandemic has brought attention to some countries' overreliance on food imports and its subsequent food security. For example, to effectively buffer from supply disruptions, Singapore aims to produce 30% of its nutritional needs by 2030. This has brought about a heightened interest in farming among the Singapore population, especially small-scale commercial indoor farming and even home farming.

[0004] Mushroom farming is generally classified into seven stages. The seven stages are: strain selection, substrate preparation, inoculation, incubation, initiation, fruiting and harvesting. During substrate preparation or during the inoculation stage, mushroom bags may be used. Single-use plastic bag use is rife within the mushroom farming industry. Plastic is a very versatile product, cheap, flexible and it can withstand a pressure cooker (pressure cookers are important in substrate preparation as they sterilize the different substrates which the mycelium is going to eat) without breaking down.

[0005] However, these benefits also make plastic very bad for the environment and with the large drive in environmental friendliness across the world, this is one area where commercial mushroom farming is falling short. This constitutes a waste and is not environmentally friendly.

[0006] Growing mushrooms can be a challenging task due to the need for a controlled environment. The traditional method of growing mushrooms involves using a large amount of space and resources. This can be problematic for those who want to grow mushrooms in small spaces. Building a device requires careful consideration of factors such as the size of the device, the materials used, and the environmental conditions required for optimal growth. Additionally, it is important to ensure that the device is easy to use and maintain for those who are new to mushroom cultivation.

[0007] There appears to be no attempt to address the aforesaid problems. As such, the present invention attempts to overcome at least in part some of the aforementioned disadvantages and to provide for an improved approach for addressing the foregoing challenge.

Summary of the Invention

[0008] According to a first aspect of the present disclosure, there is provided a mushroom growing device, the device comprising a cabinet, a housing defined within the cabinet, one or more access openings defined within the housing, a controller unit in data communication with a plurality of sensors for receiving a first sensor data from the plurality of sensors. The mushroom growing device further comprises a top surface including one or more power connectors adapted for stacking a second device on the top surface, wherein the one or more power connectors is in data communication with the controller unit and a wireless transceiver configured for receiving the first sensor data and transmitting the first sensor data to a server.

[0009] According to various embodiments, the device further comprises a bottom surface including one or more power connectors adapted for stacking a third device on the bottom surface, wherein the one or more power connectors is in data communication with the controller unit.

[0010] According to various embodiments, the wireless transceiver is configured for receiving a second sensor data from the second device and transmitting the second sensor data to the server when the second device is stacked on the top surface.

[0011] According to various embodiments, the top surface includes a coating that is ferromagnetic.

[0012] According to various embodiments, the one or more power connectors include a mechanical connector for engaging with the second device.

[0013] According to various embodiments, each power connector includes an engagement interface having an electrical contact configured for contacting with a corresponding power connector on the second device when stacked on the device.

[0014] According to various embodiments, each power connector includes a male connector and a female connector on the corresponding power connector of the second device configured to receive the male connector.

[0015] According to various embodiments, the plurality of sensors extends into the cabinet and are housed in a sensor housing located in a base portion.

[0016] According to various embodiments, each sensor includes an elongated probe for measuring a parameter.

[0017] According to various embodiments, the parameter includes one of the following: substrate moisture, pH, electrical conductivity, temperature and NPK (Nitrogen, Phosphorus, Potassium) levels.

[0018] According to various embodiments, the controller unit includes a communication interface adapted for monitoring climate conditions within the cabinet.

[0019] According to various embodiments, the communication interface includes an input device and one or more visual indicators relating to the parameter.

Brief Description of the Drawings

[0020] In the drawings, like reference characters generally refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention. The dimensions of the various features or elements may be arbitrarily expanded or reduced for clarity. In the following description, various embodiments of the invention are described with reference to the following drawings, in which:

[0021] FIG. 1 is a perspective view of a device for growing mushrooms in accordance with embodiments of the present invention;

[0022] FIG. 2 is a perspective view of another embodiment of a device for growing mushrooms in accordance with embodiments of the present invention;

[0023] FIG. 3 illustrates a perspective interior view of a device for growing mushrooms in accordance with embodiments of the present invention; and

[0024] FIG. 4 illustrates a perspective interior view of a bottom section of the device for growing mushrooms in accordance with embodiments of the present invention;

[0025] FIG. 5 illustrates a perspective view of a device for growing mushrooms stacked on top of one another in accordance with an embodiment of the present invention.

[0026] FIG. 6 illustrates a perspective view of the bottom section of the device for growing mushrooms in accordance with embodiments of the present invention;

[0027] FIG. 7 illustrates a perspective view of a top section of the device for growing mushrooms in accordance with embodiments of the present invention; and

[0028] Figure 8 illustrates a system for monitoring the growth of a horticultural product according to various embodiments.

Detailed Description

[0029] Reference will now be made in detail to an exemplary embodiment of the present invention, examples of which are illustrated in the accompanying drawings. While the invention will be described in conjunction with the embodiment, it will be understood that they are not intended to limit the invention to these embodiments. On the contrary, the invention is intended to cover alternatives, modifications, and equivalents, which may be included within the spirit and scope of the invention as defined by the appended description. Furthermore, in the following detailed description of embodiments of the present invention, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be recognized by one of ordinary skill in the art that the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, and circuits have not been

described in detail as not to unnecessarily obscure aspects of the embodiments of the present invention.

[0030] In the specification the term "comprising" shall be understood to have a broad meaning similar to the term "including" and will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps. This definition also applies to variations on the term "comprising" such as "comprise" and "comprises".

[0031] Throughout the specification and claims, the following terms take the meanings explicitly associated herein, unless the context clearly dictates otherwise. The phrase "in one embodiment" as used herein does not necessarily refer to the same embodiment, though it may. Furthermore, the phrase "in another embodiment" as used herein does not necessarily refer to a different embodiment, although it may. Thus, as described below, various embodiments of the invention may be readily combined, without departing from the scope or spirit of the invention.

[0032] In addition, as used herein, the term "or" is an inclusive "or" operator, and is equivalent to the term "and/or," unless the context clearly dictates otherwise. The term "based on" is not exclusive and allows for being based on additional factors not described, unless the context clearly dictates otherwise. In addition, throughout the specification, the meaning of "a,""an," and "the" include plural references. The meaning of "in" includes "in" and "on."

[0033] To achieve the stated features, advantages and objects, the present invention is directed to a device for growing mushrooms. More particularly, a mushroom cultivation pod is presented to address this issue. The pod is catered specially for high-value mushroom farming like *Agaricus blazei Murrill (*ABM) mushrooms. A method of harvesting such mushrooms is also described. Such pods may potentially be used for other species of

mushrooms as well. In some embodiments, the device is constructed so as be reusable. The device can be cleaned and reused for new mushroom cultivation, thus eliminating the use of plastic mushroom bags which is not environmentally friendly.

[0034] Figure 1 illustrates a perspective view of a device 100 for growing mushrooms. Mushrooms grow well in dark environment. The device 100 includes a top section 110, a body 120 and a base section 140. The top section 110 is attached to the body 120 and includes a mechanical locking connector or the like that can be attached to the top of the body 120. Similarly, the base section 140 is also attached to the body 120 and includes a mechanical locking connector or the like that can be attached to the bottom of the body 120. The device 100 includes a body 120 where the actual growth of mushroom takes place. In some embodiments, the body 120 is a cabinet that includes one or more openings for accessing the cabinet.The body 120 could be made up of darkened plastic material, like polypropylene, so that light does not pass through. The opening includes a door that can be swiveled opened during the mushroom's fruiting phase or during misting. The door is detachable and can be fully detached and re-attached. In some embodiments, the opening and closing of the door can be manually controlled or by an actuator connected to a microcontroller if automation is required. In some embodiments, the body 120 has more than one opening and can be on the opposed side of the other opening. The device 100 includes a base section 140 attached to the body 120.

[0035] Figure 2 illustrates a perspective view of yet another embodiment of a device 100 for growing mushrooms. In this embodiment, the body 120 has an opening 135, and the opening 135 includes at least one door 130 that slides laterally for access to the interior of the housing. In some embodiments, a groove rail 132 is provided at a top end and a bottom end of the opening 135. In some embodiments, the opening 135 includes two doors 130 that slides laterally in opposed directions for access to the opening 135. The door 130 is slidably attached to the groove rail 132 so that the door 130 can slide from an open to a closed position and vice versa for access to the housing. In some embodiments, the body

120 has more than one opening on another side of the body 120 that includes similar configurations of doors mentioned above.

[0036] Figure 3 illustrates a perspective view of an interior section of the body 120 in accordance with embodiments of the present invention. Figure 4 illustrates a perspective view of an interior section of the base section 140 in accordance with embodiments of the present invention. The base section 140 houses the electronic components for monitoring and powering the device 100. The base section 140 includes a controller unit 149, a plurality of sensor probes 141,142, 143, 144 electrically connected to the controller unit 149 and a power inlet 145 for receiving power from an external power source such as external cabled power source (DC or AC) through the power inlet on the cap. In some embodiments, the controller unit 149 is powered by batteries.

[0037] The base section 140 includes a sensor housing 147 adapted for holding the plurality of sensor probes and ensuring that the plurality of sensor probes can be held stable in a vertical position. The sensor housing 147 includes a plurality of openings where each opening is adapted for receiving one sensor probe. Each sensor probe is an elongated rod that is adapted for capturing data pertaining to at least one parameter when in use.

[0038] In some embodiments, each sensor probe is capable of measuring a single parameter as the end-user desires. The parameters that are measured can include substrate moisture, pH, electrical conductivity, temperature and NPK (Nitrogen, Phosphorus, Potassium constituents). Each sensor probe may be arranged on sensor housing 147 depending on its use and purpose and include other sensors that would aid in making operational horticultural or urban farming decisions.

[0039] In some embodiments, if moisture, pH and electrical conductivity are required, the base section 140 will include three sensor probes. The sensor probes will be electrically connected to the controller unit and calibrated. Eventually the base section 140 undergoes

epoxy resin curing, thus becoming completely waterproof, and do not require routine maintenance. If a particular sensor probe is not required by the end-user, the opening on the sensor housing 147 for receiving a sensor probe can be covered with a cap during the manufacturing process.

[0040] The base section 140 includes a controller unit 149 that includes other electrical components in communication with the controller unit 149. For example, other electrical components include a wireless transceiver (not shown) for transferring data received from the sensor probes to an external server or computer system, a receiver, a display interface and one or more user interface buttons. The power inlet 145 provides power from an external source to one or more components of the controller unit 149. The controller unit 149 also includes a processor (not shown) which is communicatively coupled between a memory, a light emitting device, the display interface, and one or more user interface buttons.

[0041] In some embodiments, the processor may be an application specific integrated circuit, a digital signal processor, or a microcontroller or the like. The memory may be a random access memory (RAM) and may refer to any type of computer storage medium, including long term, short term, and is not limited to any particular type of memory or type of data upon which memory is stored. The processor processes the sensor data by for example, time-stamping or including GPS information on the sensor data and transmitting the sensor data to the memory for storage. The controller unit 149 also includes a wireless transceiver for transmission of sensor data to an external computer system or to any computing system via the communications network. The controller unit 149 may also include a communications interface adapted for transmitting and receiving of sensor data from the controller unit 149 to other computing systems. This allows the controller unit 149 to be connected to a wide variety of computing systems or devices for data upload and data download. The display interface allows for visual monitoring of the conditions that are essential for maintaining horticultural or mushroom health. The display interface displays visual indicators that provide useful information to the grower for making

decisions pertaining to the conditions in the housing of the device where the mushrooms are located. When taking readings from the housing, the display interface will display the progress of the reading; signaling to the user when it is complete.

[0042] Figure 5 illustrates a perspective view of a device for growing mushrooms stacked on top of one another in accordance with an embodiment of the present invention. In some embodiments, the top section 110 and the base section 140 of the device 100 includes a top surface and a bottom surface respectively that is constructed so as to provide a scalable design. In some embodiments, the base section 140 is integrated with the body 120 such that the base section 140 is part of the body 120. In some embodiments, the top section 110 is integrated with the body 120 such that the top section 110 is part of the body 120. In some embodiments, the top section 110 and base section 140, or the top surface or the bottom surface of the body 120, are metallic or the top surface and the bottom surface of the top section 110 and the base section 140 respectively includes a surface that is ferromagnetic in nature. In some embodiments, the base section is painted with a ferrous coating that is metallic or ferromagnetic in nature, and the top surface of the top cover is coated with a magnetic coating to form a ferrous-magnetic pairing that allows the devices to be stacked vertically on top of another device. In some embodiments, the top surface of the top section is painted with a ferrous coating that is metallic or ferromagnetic in nature, and the bottom surface of the base section is coated with a magnetic coating to form the ferrous-magnetic pairing. The ferromagnetic nature of the surface allows many such identical or similar devices to be stacked on top of one other.

[0043] In some embodiments, the top surface and the bottom surface of the top section and base section respectively, or the top surface and the bottom surface of the body 120 include device connectors for securing a second device for stacking on the first device. In some embodiments, the device connectors are adapted to provide a releasable connection with device connectors of the second device so that the second device can be easily detached from the device. In some embodiments, the device connectors can be a male-female

connector suitable for releasable detachment from the second device. For example, the device includes a male connector that is releasably secured to a female connector of the second device. In some embodiments, any mechanical connection such that the devices can be stacked in a stable configuration can be used. The provides the advantage of the ability of the devices to be stacked on top of one another to scale up farming vertically.

[0044] When the devices are in a stacked configuration, i.e. one on top of another, power and sensor data can be transferred from one device to another device via electrical and signal communication between the devices through a powerline communication. FIG. 6 illustrates a perspective view of the bottom section of the device in accordance with embodiments of the present invention. In a stacked configuration, the bottom-most device 100 is the master node where it can send command signals to other (slave) nodes stacked on top of the device to receive other devices' sensors' data. Each device includes at least a conductive strip in electrical communication with the power inlet or a power source. The conductive strip runs from the base section 140 through the body 120 and to the top section 110. The device includes power connectors on the top surface of the top section 110 or the body 120 that allows a second device stacked on top of the device 100 to connect with the power connectors for the purpose of receiving and transmitting power and sensor data to the master device 100 (the bottom-most device). In some embodiments, the second device includes power connectors on its bottom surface for electrical engagement with the power connectors on the top surface of the body 120. Command signals and data are modulated onto the lines that provides power to the devices (i.e powerline communication). The power lines carry alternating current (AC) power from the bottom device in the stack to the topmost device in the stack. The bottom device will be connected to the mains through the power inlet. The AC power received from the external cable undergoes conversion in a power converter device 156 to supply direct current (DC) to the electrical components at the base section 140. The DC power is also delivered to the pair of conductor strips from the power socket via a terminal block 154. The top and bottom section includes electrical connectors that easily allows the base section of the top device to mate with the top section

of the bottom device, hence allowing current to pass from one device to the next device on top. In some embodiments, the power connectors on the top surface or the bottom surface are retractable into the body or extendable out of the body when desired. In some embodiments, the power connectors are adjustable such that they can be retracted and extended to a desired length for engagement with the second or third device.

[0045] The power supply unit is in electrical communication with the power connectors on the top surface and bottom surface of the device 100 through the conductive strip running along the height of the device 100. The power connectors each include an engagement interface which is an electrical contact that are configured to contact with corresponding power connectors on second or third devices when stacked on the device 100. The power connectors includes one or more electrical contacts. In some embodiments, each power connector includes one male connector and one female connector on the corresponding power connector of the second device configured to receive the male connector. The use of power connectors allow second and third devices to be stacked on the master device in a seamless and continuous manner.

[0046] In some embodiments, the controller unit 140 of the master device 100 includes the wireless transceiver configured for receiving a first sensor data received from the plurality of sensors in the sensor housing of the device 100 and transmitting the first sensor data to a server. In other embodiments, the wireless transceiver is configured to receive a second sensor data received from a second device that is stacked on the master device 100. The second sensor data includes sensor data received from the plurality of sensors in the sensor housing of the second device that is stacked on the master device 100. The second sensor data is transmitted to the master device 100 through the power connectors. In other words, when the second device is stacked on the master device 100, the controller unit 149 and the wireless transceiver of the master device 100 is configured to receive the first sensor data and the second sensor data from the master device 100 and the second device respectively, and to transmit said first sensor data and the second sensor data to the server wirelessly via

a network or through a wired communication. Similarly, when a third device is stacked on the second device, the wireless transceiver of the master device 100 is configured to receive a third sensor data received from a plurality of sensors in the third device that is stacked on the second device 100 through the power connectors in electrical communication with the second device and the master device 100.

[0047] When the device is in use, during substrate preparation, the substrate can be directly added to the body 120 without separately being sanitized as in the traditional case with the usage of a mushroom bag. After the substrate is added, the base section can be removed (if not already removed), the top section placed onto the body 120, and then the device is placed into an autoclave or pressure cooker for sterilization. If the sensor probes are going to be inserted after the sterilization stage, the holes can be covered with a small piece of paper or similar if there is concern that substrate might drop through the holes during preparation. After substrate preparation, spores or mycelium are inoculated to the sterilized substrate. The base section can be placed back. If the base section contains sensor probes, they can be inserted into the substrate slowly but easily as the tip is fairly sharp. The device is then left to let the mycelium colonize the substrate. The door 130 on the device can be fully closed or slightly ajar to allow air to circulate through the substrate. The door 130, if required, could be made of a transparent material so that the growth of the mycelium through the substrate could be observed. The device is placed in a grow room. As the walls of the device is dark, lighting requirement could be more flexible as compared to the traditional method of using mushroom bag, where the environment need to be dark. The transition to fruiting mushrooms begins when the substrate is fully colonized with mycelium. The opening could then be opened wider or be fully opened or detached (figure 1). Substrate conditions can be acquired by the sensors and corresponding actions be taken, for example if moisture is low, humidity in the grow room can be increased by misting, automatically (as part of an internet –of –things system) or manually.

[0048] Figure 8 illustrates a system for monitoring the growth of a horticultural product according to various embodiments. The system 200 may include one or more devices 100a, 100b, 100c, for growing horticultural products, and a server 210 in communication with a client device 220 over a communication network 230. Although the singular is used to describe the server 210, the server 210 as described herein may operate as a single computing device, a set of computing devices, or a distributed computing cluster. Similarly, a client device 220 may be one or more programming devices capable of running a web application or native application to communicate with the server 210 to receive the sensor data from the one or more devices 100 for monitoring the growth of the horticultural product within the devices. The server 210 and/or client device 220 may have one or more processors configured to execute instructions retained in the database or memory. In some embodiments, the server 210 and/or client device 220 may include servers, computers, laptops, notebooks, portable handheld computers, mobile communication devices, smart phones, personal digital assistants, tablets, wearable devices, Internet of Things (IoT) devices, or any other communication devices capable of sending and receiving data over the network 230.

[0049] In some embodiments, the devices include a master device 100a and one or more slave devices (eg. 100b, 100c) that are in electrical communication with the master device 100a. The master device 100a includes a wireless transceiver (not shown) for receiving and transmitting a first sensor data received from a plurality of sensors from the master device to the client device 220 via a server 210 over the communication network 230. In other embodiments, the wireless transceiver is configured to receive a second sensor data received from the first slave device 100b that is stacked on the master device 100a. The second sensor data includes sensor data received from the plurality of sensors in the sensor housing of the first slave device 100b that is stacked on the master device 100a. The second sensor data is transmitted to the master device 100a through the power connectors. In other words, when the first slave device 100b is stacked on the master device 100a, the controller unit 149 and the wireless transceiver of the master device 100 is configured to receive the

first sensor data and/or the second sensor data from the master device 100 and the first slave device 100b respectively, and to transmit said first sensor data and the second sensor data to the server 210 wirelessly via a network 230. Similarly, when a second slave device 100c is stacked on the first slave device 100b, the wireless transceiver of the master device 100a is configured to receive a third sensor data received from a plurality of sensors in the second slave device 100c that is stacked on the first slave device 100b through the power connectors in electrical communication with the second slave device 100 cand the master device 100.

[0050] In some embodiments, the server 210 can be a cloud server hosted remotely or a local server that is within the premises where the devices are located. When the devices are in a stacked configuration, i.e., the master device 100a are electrically connected to the slave devices 100b, 100c, the master pod 100a receives sensor data (eg. Second sensor data or third sensor data) from one or more of the slave devices 100b, 100c and transmits the sensor data to the client device 220 via the server 220 over the communication network 230. The sensor data is transferred from the slave devices 100b, 100c to the master device 100a via the powerline communication or a similar means of transmission. In some embodiments, each of the slave devices 100b, 100c includes a wireless transceiver for transmitting sensor data directly to the client device 220 via the server 220 over the communication network 230.

[0051] As used herein, the term ‘network’ refers to a Local Area Network (LAN), a Metropolitan Area Network (MAN), a Wide Area Network (WAN), a Low Power Wide Area Network (LPWAN), a cellular network, a proprietary network, and/or Internet Protocol (IP) network such as the Internet, an Intranet or an extranet. Each device, module or component within the system may be connected over a network or may be directly connected. A person skilled in the art will recognize that the terms ‘network’, ‘computer network’ and ‘online’ may be used interchangeably and do not imply a particular network embodiment. In general, any type of network may be used to implement the online or

computer networked embodiment of the present invention. The network may be maintained by a server or a combination of servers or the network may be serverless. Additionally, any type of protocol (for example, HTTP, FTP, ICMP, UDP, WAP, SIP, H.323, NDMP, TCP/IP) may be used to communicate across the network. The devices as described herein may communicate via one or more such communication networks.

[0052] While the invention has been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the appended claims. The scope of the invention is thus indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced.