FORM 2
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COMPLETE SPECIFICATION

(See section 10 and rule 13)

1. TITLE OF THE INVENTION

An Autonomous Sprinkler System And A Method For Irrigation In A Field

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3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification particularly describes the invention and the manner in which it is to be performed.

FIELD OF THE INVENTION

The present disclosure relates to irrigation, more particularly, to an autonomous sprinkler system and a method for irrigation in a field.

BACKGROUND

With the advancement in the field of crop irrigation, automated systems are employed for assisting an operator for proper irrigation of a field by delivering the required amount of water content, nutrients or pesticides to crops, and accurate crop data collection. Currently, there are several automated irrigation systems, such as a time-based system, an open-loop system, a closed-loop system, a real-time feedback system, and a computer-based irrigation system, employed for improving irrigation of the field. In the time-based systems, timers and time clock controllers are used to control irrigation of the field. A pre-defined time interval is set for each irrigation cycle and the time clock controllers are adapted to trigger the irrigation cycle based on the pre-defined time interval.

Further, in the open-loop system, the operator defines a volume of water to be supplied or a time duration of each irrigation cycle. The open-loop system is employed with a clock that helps in the termination of the supply of water based on the time duration or based on the volume of water. In the closed-loop system, a controlling strategy is developed by the operator, and subsequently the closed-loop system takeover the controls and supply the water in the field based on feedback provided by various sensors. In the real-time feedback system, the supply of the water is based on real-time dynamic factors within the fixed parameters.

Further, in the computer-based system, a combination of software and hardware is incorporated which acts as a supervisor for the management of the irrigation system and other practices like fertigation. However, all the aforesaid systems are configured to supply the water to the field based on pre-defined quantity or variation and based on a current state of the field. The aforesaid systems fail to consider dynamic environmental factors, such as weather forecast, atmospheric humidity, transpiration, sunlight, daylight hours, and wind speed. Therefore, there is a need for an improved solution for irrigating the field.

SUMMARY

This summary is provided to introduce a selection of concepts, in a simplified format, that are further described in the detailed description of the invention. This summary is neither intended to identify key or essential inventive concepts of the invention and nor is it intended for determining the scope of the invention.

In an embodiment, an autonomous sprinkler system for irrigation in a field is disclosed. The autonomous sprinkler system includes a plurality of sensors disposed at a plurality of locations in the field. Each of the plurality of sensors is adapted to measure an amount of water content associated with a location from among the plurality of locations. Further, the autonomous sprinkler system may include a controlling unit in communication with the plurality of sensors. The controlling unit is configured to receive information indicative of the amount of water content associated with each of the plurality of locations from each of the plurality of sensors. Further, the controlling unit is configured to obtain a first set of data associated with a plurality of environmental factors and a second set of data associated with plantation in the field. The controlling unit is configured to determine at least one portion of the field to be irrigated based on the amount of water content associated with each of the plurality of locations, the first set of data, and the second set of data. Further, the controlling unit is configured to actuate at least one sprinkler disposed in vicinity of the determined portion of the field.

In another embodiment, a method of irrigating a field by an autonomous sprinkler system is disclosed. The method includes receiving, by a controlling unit, information indicative of an amount of water content associated with each of a plurality of locations in the field from each of a plurality of sensors disposed at the plurality of locations. Further, the method includes obtaining, by the controlling unit, a first set of data associated with a plurality of environmental factors and a second set of data associated with plantation in the field. The method includes determining, by the controlling unit, at least one location from among the plurality of location in the field to be irrigated based on the amount of water content associated with each of the

plurality of locations, the first set of data, and the second set of data. Further, the method includes actuating, by the controlling unit, at least one sprinkler disposed in vicinity of the determined location.

To further clarify advantages and features of the present invention, a more particular description of the invention will be rendered by reference to specific embodiments thereof, which is illustrated in the appended drawings. It is appreciated that these drawings depict only typical embodiments of the invention and are therefore not to be considered limiting of its scope. The invention will be described and explained with additional specificity and detail with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

Figure 1 illustrates an environment depicting an autonomous sprinkler system in communication with an irrigation system, according to an embodiment of the present disclosure;

Figure 2 illustrates a schematic view of a controlling unit of the autonomous sprinkler system, according to an embodiment of the present disclosure;

Figure 3 illustrates an exemplary field map indicating positions a plurality of sensors, a plurality of sprinklers, and an area of influence associated with each of the plurality of sprinklers in a field, according to an embodiment of the present disclosure;

Figure 4 illustrates an exemplary first 3D-map indicating the amount of water content across the field, according to an embodiment of the present disclosure;

Figures 5a-5c illustrate exemplary second 3D-maps indicating an amount of water content retained across the field due to environmental factors, according to an embodiment of the present disclosure;

Figure 6 illustrates an exemplary graph depicting a required amount of water content associated with different types of crops, according to an embodiment of the present disclosure;

Figure 7 illustrates an exemplary third 3D-map indicating the required amount of water content corresponding to a type of plantation at a determined age across the field, according to an embodiment of the present disclosure;

Figure 8 illustrates an exemplary fourth 3D-map indicating the amount of water content to be supplied across the field, according to an embodiment of the present disclosure;

Figure 9 illustrates an exemplary map depicting actuation of at least one sprinkler to irrigate at least one portion of the field, according to an embodiment of the present disclosure; and

Figure 10 illustrates a flowchart depicting a method of irrigating a field by an autonomous sprinkler system, according to an embodiment of the present disclosure.

Further, skilled artisans will appreciate that elements in the drawings are illustrated for simplicity and may not have been necessarily been drawn to scale. For example, the flow charts illustrate the method in terms of the most prominent steps involved to help to improve understanding of aspects of the present invention. Furthermore, in terms of the construction of the device, one or more components of the device may have been represented in the drawings by conventional symbols, and the drawings may show only those specific details that are pertinent to understanding the embodiments of the present invention so as not to obscure the drawings with details that will be readily apparent to those of ordinary skill in the art having benefit of the description herein.

DETAILED DESCRIPTION OF FIGURES

For the purpose of promoting an understanding of the principles of the invention, reference will now be made to the embodiment illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated system, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

Embodiments of the present invention will be described below in detail with reference to the accompanying drawings.

Figure 1 illustrates an environment depicting an autonomous sprinkler system 100 in communication with an irrigation system 102, according to an embodiment of the present disclosure. The irrigation system 102 may be deployed in a field for irrigating plantation grown in the field. In an embodiment, the irrigating system 102 may be deployed to supply a controlled amount of water to plants grown in the filed at needed intervals. The irrigation system 102 may include, but is not limited to, a controlling module 104, a plurality of solenoid valves 106 in communication with the controlling module 104, a plurality of sprinklers 108, and a flowmeter 110 in communication with the controlling module 104.

In an embodiment, the plurality of sprinklers 108 may be interchangeably be referred to as the sprinklers 108, without departing from the scope of the present disclosure. Further, the sprinklers 108 may individually be referred to as the sprinkler 108, without departing from the scope of the present disclosure. In the illustrated embodiment, the sprinklers 108, such as the sprinkler 108-1, the sprinkler 108-2,….., and the sprinkler 108-n, may be adapted to irrigate the plantation in the field by supplying water in a controlled manner. Each of the sprinklers 108 may be disposed at different locations in the field and adapted to supply water in an area surrounding the respective sprinkler.

As mentioned earlier, the controlling module 104 may be in communication with the plurality of solenoid valves 106. In an embodiment, the controlling module 104 may be configured to actuate the plurality of solenoid valves 106 to operate the sprinklers for supplying water in the field. The plurality of solenoid valves 106 may interchangeably be referred to as the solenoid valves 106, without departing from the scope of the present disclosure. Further, the solenoid valves 106 may individually be referred to as the solenoid valve 106. In the illustrated embodiment, the solenoid valves 106, such as the solenoid valve 106-1, the solenoid valve 106-2,…., and the solenoid valve 106-n may be in communication with the controlling module 104.

Each of the solenoid valves 106 may be deployed in each of the plurality of sprinklers 108 to restrict or to allow a flow of water to the respective sprinkler. The controlling module 104 may be configured to actuate each of the solenoid valves 106 in an open condition and a closed condition. In the open condition, the flow of water may be allowed to the sprinkler 108 through the solenoid valve 106. Further, in the closed condition, the flow of water may be restricted to the sprinkler 108 through the solenoid valve 106.

For instance, referring to Figure 1, if the controlling module 104 actuates the solenoid valve 106-1 to the open condition, then the sprinkler 108-1 may supply water to the area in the surrounding of the sprinkler 108-1 in the field. Similarly, if the controlling module 104 actuates the solenoid valve 106-n to the open condition, then the sprinkler 108-1 may supply water to the area in the surrounding of the sprinkler 108-1 in the field.

Further, the irrigation system 102 may be in communication with the autonomous sprinkler system 100 through a network 112. In an embodiment, the network 112 may be a wired network or a wireless network. The network 112 may include, but is not limited to, a mobile network, a broadband network, a Wide Area Network (WAN), a Local Area Network (LAN), and a Personal Area Network.

The autonomous sprinkler system 100 may be configured to determine at least one portion of the field to be irrigated based on an amount of water content at different locations in the field, various environmental factors, and a type of plantation in the field. The autonomous sprinkler system 100 may determine at least one portion of the field, in real-time, which is needed to be irrigated by the irrigation system 102. Accordingly, the autonomous sprinkler system 100 may be configured to communicate information associated with the sprinklers 108 to be actuated for irrigating the determined portions of the field. Based on the information, the controlling module 104 of the irrigation system 102 may operate at least one of the solenoid valves 106 to allow the flow of water to the respective sprinklers 108 for irrigating the determined portions of the field.

Referring to Figure 1, in the illustrated embodiment, the autonomous sprinkler system 100 may include, but is not limited to, a controlling unit 114, a plurality of sensors 116, a plurality of applications 118. The plurality of sensors 116 and the plurality of applications 118 may be in communication with the controlling unit 114. The controlling unit 114 may be in communication with the controlling module 104 of the irrigation system 102 through the network 112. In an embodiment, the plurality of applications 118 may include, but is not limited to, weather applications, without departing from the scope of the present disclosure. In an embodiment, the plurality of applications 118 may be deployed in a remote server in communication with the controlling unit 114 of the autonomous sprinkler system 100.

Figure 2 illustrates a schematic view of the controlling unit 114 of the autonomous sprinkler system 100, according to an embodiment of the present disclosure. In an embodiment, the plurality of sensors 116 may interchangeably be referred to as the sensors 116, without departing from the scope of the present disclosure. Further, the sensors 116 may individually be referred to as the sensor 116. In the illustrated embodied, the sensors 116, such as the sensor 116-1, the sensor 116-2,…., and the sensor 116-n, may be disposed at a plurality of locations in the field.

Each of the sensors 116 may be adapted to measure an amount of water content associated with the location from among the plurality of locations. For instance, the sensor 116-1 may be adapted to measure an amount of water content associated with the location from among the plurality of locations at which the sensor 116-1 is positioned in the field. Similarly, the sensor 116-2 adapted to measure an amount of water content associated with the location from among the plurality of locations at which the sensor 116-2 is positioned in the field.

As mentioned earlier, each of the sensors 116 may be in communication with the controlling unit 114 of the autonomous sprinkler system 100. Referring to Figure 2, the controlling unit 114 may include a processor 202, memory, module(s) 204, and data 206. The module(s) 204 and the memory are coupled to the processor 202. The processor 202 can be a single processing unit or a number of units, all of which could include multiple computing units. The processor 202 may be implemented as one or more microprocessors, microcomputers, microcontrollers, digital signal processors, central processing units, state machines, logic circuitries, and/or any devices that manipulate signals based on operational instructions. Among other capabilities, the processor 202 is configured to fetch and execute computer-readable instructions and data stored in the memory.

The memory may include any non-transitory computer-readable medium known in the art including, for example, volatile memory, such as static random access memory (SRAM) and dynamic random access memory (DRAM), and/or non-volatile memory, such as read-only memory (ROM), erasable programmable ROM, flash memories, hard disks, optical disks, and magnetic tapes.

The module(s) 204, amongst other things, include routines, programs, objects, components, data structures, etc., which perform particular tasks or implement data types. The module(s) 204 may also be implemented as, signal processor(s), state machine(s), logic circuitries, and/or any other device or component that manipulate signals based on operational instructions.

Further, the module(s) 204 may be implemented in hardware, instructions executed by at least one processing unit, e.g., the processor 202, or by a combination thereof. The processing unit may comprise a computer, a processor, a state machine, a logic array and/or any other suitable devices capable of processing instructions. The processing unit may be a general-purpose processor which executes instructions to cause the general-purpose processor to perform operations or, the processing unit may be dedicated to perform the required functions. In some example embodiments, the module(s) 204 may be machine-readable instructions (software, such as web-application, mobile application, program, etc.) which, when executed by a processor/processing unit, perform any of the described functionalities.

In an implementation, the module(s) 204 may include a data obtaining module 208, a map generating module 210, and a location determining module 212. The data obtaining module 208, the map generating module 210, and the location determining module 212 are in communication with each other. The data serves, amongst other things, as a repository for storing data processed, received, and generated by one or more of the modules 204.

The controlling unit 114 may be configured to determine the plurality of locations at which the plurality of sensors 116 is disposed. In an embodiment, the data obtaining module 208 may be configured to determine the plurality of locations at which the plurality of sensors 116 is disposed. The data obtaining module 208 may receive an input indicative of locations of the plurality of sensors 116. Based on the received input, the data obtaining module 208 may determine the plurality of locations at which the plurality of sensors 116 is disposed. In an embodiment, based on the input indicative of locations of the plurality of sensors 116 received from a user, the controlling unit 114 may be configured to generate a suggestion indicative of a pattern of locations at which the plurality of sensors 116 can be disposed to increase overall efficiency of the autonomous sprinkler system 100.

Further, the controlling unit 114 may be configured to obtain a location of each of the plurality of sprinklers disposed in the field. In an embodiment, the controlling unit 114 may be configured to receive an input indicative of the location of each of the plurality of sprinklers disposed in the field. In an embodiment, the data obtaining module 208 may receive an input indicative of the location of each of the plurality of sprinklers disposed in the field. As mentioned earlier, the data obtaining module 208 may be in communication with the map generating module 210 of the controlling unit 114.

The controlling unit 114 may be configured to generate a field map indicating locations of each of the plurality of sensors 116, each of the plurality of sprinklers disposed in the field, and an area of influence associated with each of the plurality of sprinklers. In an embodiment, the data obtaining module 208 may be configured to transmit information indicative of the location of each of the plurality of sprinklers disposed in the field and the location of each of the plurality of sensors 116 disposed in the field to the map generating module 210. Subsequently, the map generating module 210 may be configured to generate the field map indicating locations of each of the plurality of sensors 116, each of the plurality of sprinklers disposed in the field, and the area of influence associated with each of the plurality of sprinklers.

Figure 3 illustrates an exemplary field map indicating positions a plurality of sensors 116, a plurality of sprinklers, and an area of influence associated with each of the plurality of sprinklers in a field, according to an embodiment of the present disclosure. Referring to Figure 3, an X-axis and a Y-axis of the field map collectively indicate an area of the field to be irrigated. The field map indicates locations of each of the plurality of sprinklers disposed in the field. For instance, the location of the sprinkler 108-1 from among the plurality of sprinklers is indicated by coordinates X1, Y1 in the field. Similarly, the location of the sprinkler 108-2 from among the plurality of sprinklers is indicated by coordinates X2, Y2 in the field

Referring to Figure 3, the field map indicates the area of influence associated with each of the plurality of sprinklers. For instance, the area of influence associated with the sprinkler 108-1 is denoted by A1 in the field map. Similarly, the area of influence associated with the sprinkler 108-2 is denoted by A2 in the field map. Further, the field map indicates the location of each of the plurality of sensors 116 disposed in the field. For instance, the location of the sensor 116-1 is indicated by coordinates X3, Y3 in the field. Similarly, the location of the sensor 116-2 is indicated by coordinates X4, Y4 in the field. Further, the location of the sensor 116-3 is indicated by coordinates X5, Y5 in the field.

As mentioned earlier, the controlling unit 114 may be in communication with each of the plurality of sensors 116. The controlling unit 114 may be configured to receive information indicative of the amount of water content associated with each of the plurality of locations from each of the plurality of sensors 116. In an embodiment, the data obtaining module 208 may receive information indicative of the amount of water content associated with each of the plurality of locations from each of the plurality of sensors 116.

For instance, the data obtaining module 208 may receive information, from the sensor 116-1, indicative of water content associated with a location from among the plurality of locations at which the sensor 116-1 is disposed in the field. Similarly, the data obtaining module 208 may receive information, from the sensor 116-2, indicative of water content associated with a location from among the plurality of locations at which the sensor 116-2 is disposed in the field. Further, the data obtaining module 208 may receive information, from the sensor 116-n, indicative of water content associated with a location from among the plurality of locations at which the sensor 116-n is disposed in the field.

The controlling unit 114 may be configured to determine an amount of water content associated with a plurality of intermediate locations in the field by interpolating the information received from the plurality of sensors 116. In an embodiment, the map generating module 210 may be configured to receive information indicative of water content associated with the plurality of locations at which the sensors 116 are disposed in the field from the data obtaining module 208. The map generating module 210 may determine the amount of water content associated with the plurality of intermediate locations in the field by interpolating the information received from the data obtaining module 208.

For instance, referring to Figure 3, the data obtaining module 208 may receive information indicative of water content at locations, such as (X3, Y3) and (X4, Y4), from the sensor 116-1 and the sensor 116-2, respectively. Further, the data obtaining module 208 may transmit information indicative of water content at locations, such as (X3, Y3) and (X4, Y4), to the map generating module 210. Subsequently, upon receiving information from the sensors 116 disposed in the field, the map generating module 210 may interpolate the received information to determine the amount of water content associated with the plurality of intermediate locations between the locations, such as (X3, Y3) and (X4, Y4) in the field.

Further, the controlling unit 114 may be configured to generate a first 3D-map indicating the amount of water content across the field at the plurality of intermediate locations and the plurality of locations of the plurality of sensors 116 based on the interpolation. In an embodiment, the map generating module 210 may be configured to generate the first 3D-map indicating the amount of water content across the field at the plurality of intermediate locations and the plurality of locations of the plurality of sensors 116. In particular, the first 3D-map indicates the amount of water content at each location across the field.

Figure 4 illustrates an exemplary first 3D-map indicating the amount of water content across the field, according to an embodiment of the present disclosure. An X-axis and a Y-axis of the first 3D-map collectively indicate an area of the field to be irrigated. Further, a Z-axis indicates the amount of water content at different locations across the area of the field. For instance, coordinates, i.e., X1, Y1, Z1, indicates the amount of water, i.e., Z1 at the location, i.e., (X1, Y1), in the field. Similarly, coordinates, i.e., X2, Y2, Z2, indicates the amount of water, i.e., Z2 at the location, i.e., (X2, Y2) in the field. Further, coordinates, i.e., X3, Y3, Z3, indicates the amount of water, i.e., Z3 at the location, i.e., (X3, Y3) in the field.

Further, the controlling unit 114 may be configured to obtain a first set of data associated with a plurality of environmental factors and a second set of data associated with a type of plantation in the field. In an embodiment, the data obtaining module 208 may in communication with the plurality of applications 118, such as weather applications. In an embodiment, the data obtaining module 208 may obtain the first set of data associated with the plurality of environmental factors from the plurality of applications 118.

The plurality of environmental factors may include, but is not limited to, a precipitation, an atmospheric humidity, a daylight time, a wind speed, a rate of evaporation, a rate of infiltration, and a temperature associated with the field. Further, the first set of data may include, but is not limited to, a real-time value associated with each of the environmental factors and a forecast value associated with each of the environmental factors. In an example, the first set of data may include a maximum temperature, a minimum temperature, precipitation during day, and precipitation during night. In such an example, the data obtaining module 208 may compute the rate of evaporation based on the maximum temperature, the minimum temperature, the precipitation during day, and the precipitation during night received from the plurality of applications 118.

Figures 5a-5c illustrate exemplary 3D-maps indicating the amount of water content retained across the field due to environmental factors, according to an embodiment of the present disclosure. The controlling unit 114 may be configured to determine an amount of precipitation in the field based on the first set of data associated with the environmental factors. In an embodiment, the data obtaining module 208 may determine the amount of precipitation in the field based on the location of the field from the applications 118, such as weather applications.

In an embodiment, the data obtaining module 208 may receive the location of the plantation from a Global Positioning System (GPS), without departing from the scope of the present disclosure. In another embodiment, the data obtaining module 208 may receive an input indicative of the location of the plantation. Further, based on the location of the plantation, the data obtaining module 208 may determine the amount precipitation in the field from the weather applications. The data obtaining module 208 may transmit information associated with the amount of precipitation in the field to the map generating module 210. Referring to Figure 5a, the map generating module 210 may be configured to generate a 3D-map indicative of the amount of water content at each location in the field resulting from precipitation, based on the amount of precipitation received from the data obtaining module 208.

Further, the controlling unit 114 may be configured to ascertain an amount of water content evaporated from the field based on the first set of data associated with the environmental factors. In an embodiment, the data obtaining module 208 may determine the amount of water content evaporated from the field based on the location of the field from the applications 118, such as weather applications. The data obtaining module 208 may determine the amount of water content evaporated from the field based on the environmental factors, such as the temperature, environmental humidity, and sunlight, received from the weather applications corresponding to the location of the field.

The data obtaining module 208 may transmit information associated with the amount of water content evaporated from the field to the map generating module 210. Referring to Figure 5b, the map generating module 210 may be configured to generate a 3D-map indicative of the amount of water content evaporated from each location in the field resulting from evaporation, based on the information, such as the rate of evaporation, received from the data obtaining module 208.

The controlling unit 114 may be configured to compute an amount of water content retained at each of the plurality of intermediate locations and each of the plurality of locations in the field based on a difference between the amount of precipitation and the amount of water content evaporated. In an embodiment, the map generating module 210 may be configured to compare the 3D-map indicative of the amount of precipitation in the field and the 3D-map indicative of the amount of water content evaporated from each location in the field. Based on the comparison, the map generating module 210 may compute an amount of water content retained at each of the plurality of intermediate locations and each of the plurality of locations in the field.

In an embodiment, the map generating module 210 may also determine an amount of water lost due to infiltration considering a permeability of the soil of the plantation. In such an embodiment, based on the amount of precipitation, the amount of water content evaporated, and the amount of water lost due to infiltration, the map generating module 210 may determine the amount of water content retained at each of the plurality of intermediate locations and each of the plurality of locations in the field.

Further, the controlling unit 114 may be configured to generate a second 3D-map indicating the amount of water content retained across the field. Referring to Figure 5c, the map generating module 210 may generate the second 3D-map indicating the amount of water content retained across the field. In particular, the second 3D-map indicates the amount of water content retained at each location in the field, owing to the plurality of environmental factors associated with the location of the field. For instance, referring to the second 3D-map, the amount of water content retained at a location, i.e., (X1, Y1) is indicated by Z1'.

The data obtaining module 208 may obtain the second set of data associated with plantation in the field. The second set of data may include, but is not limited to, a type of plantation, a required amount of water content, date of plantation, a type of soil of plantation, a location of plantation, an area of plantation, and data associated with fertigation. In an embodiment, the data obtaining module 208 of the controlling unit 114 may be configured to receive an input indicative of selection of the type of plantation from among a plurality of plantations. For example, the plurality of plantations may include, but is not limited to, Rice plantation, Wheat plantation, Cotton plantation, and Fruits plantation, without departing from the scope of the present disclosure.

In an embodiment, the autonomous sprinkler system 100 may include a user interface (not shown) configured to be operated by a user for providing the input indicative of selection of the type of plantation to the controlling unit 114. The user interface may be in communication with the controlling unit 114 of the autonomous sprinkler system 100. The user interface may include, but is not limited to, a touch screen, without departing from the scope of the present disclosure.

Further, the data obtaining module 208 may be configured to receive an input indicative of the date of plantation associated with the selected type of plantation. In an embodiment, the data obtaining module 208 may be configured to receive the input from the user interface, without departing from the scope of the present disclosure. The controlling unit 114 may be configured to determine, based on the second set of data, an age associated with the type of plantation in the field and the required amount of water content at the determined age of the type of plantation.

In an embodiment, the data obtaining module 208 may determine the age associated with the type of plantation, i.e., the selected type of plantation, in the field based on the received input indicative of the date of plantation. The data obtaining module 208 may compare a current date with the date of plantation associated with the selected type of plantation to determine the age of associated with the selected type of plantation. For instance, the date of plantation received by the data obtaining module 208 is 1st March, 2020 on the current date, i.e., 1st May, 2020, then the age of the selected type of plantation is determined as 61 days.

Further, the data obtaining module 208 may be configured to obtain, from a pre-stored data, the required amount of water content associated with the selected type of plantation. The pre-stored data may include, but is not limited to, the required amount of water content corresponding to each of the plurality of plantations. In an embodiment, the pre-stored data may be stored in a form of a 2D-graph indicating the required amount of water content corresponding to each of the plurality of plantations at different ages of each of the plurality of plantations. In an embodiment, the term ‘plantation’ may interchangeably be referred to as the ‘crop’ in the subsequent sections of the present disclosure, without departing from the scope of the present disclosure.

Figure 6 illustrates an exemplary graph depicting the required amount of water content associated with different types of crops, according to an embodiment of the present disclosure. Referring to Figure 6, the graph depicts the required amount of water content associated with five crops, such as crop 1, crop 2, crop 3, crop 4, and crop 5. In the illustrated embodiment, an X-axis of the graph indicates the age of the crop and a Y-axis of the graph indicates the required amount of water content associated with the crop. In one embodiment, the graph as depicted in the Figure 6 may be stored in the memory of the controlling unit 114. In another embodiment, the graph may be stored in a remote sever in communication with the controlling unit 114.

Referring to Figure 2 and Figure 6, in the illustrated embodiment, the data obtaining module 208 may be configured to obtain the required amount of water content from the graph based on the selected type of plantation and the determined age of the plantation. As mentioned earlier, the data obtaining module 208 may be in communication with the map generating module 210 of the controlling unit 114. The data obtaining module 208 may be configured to transmit the required amount of water content corresponding to the selected type of plantation in the field at the determined age of plantation to the map generating module 210.

Figure 7 illustrates an exemplary 3D-map indicating the required amount of water content corresponding to a type of plantation at a determined age across the field, according to an embodiment of the present disclosure. The controlling unit 114 may be configured to generate a third 3D-map indicating the required amount of water content for the type of plantation at the determined age across the field based on the second set of data. In an embodiment, the map generating module 210 may receive the second set of data, such as the location of plantation, the area of plantation, the required amount of water content, the type of plantation, and the age of the plantation. Subsequently, based on the received second set of data, the map generating module 210 may generate the third 3D-map indicating the required amount of water content for the type of plantation at the determined age across the field.

Referring to Figure 7, an exemplary third 3D-map indicates the required amount of water content at each location across the field for the selected type of plantation at the determined age of the plantation. An X-axis and a Y-axis of the third 3D-map collectively indicate an area of the field to be irrigated. Further, a Z-axis indicates the required amount of water content at different locations across the area of the filed. For instance, coordinates, i.e., X1, Y1, Z1’’, indicates the required amount of water, i.e., Z1’’ at the location, i.e., (X1, Y1), in the field. Similarly, coordinates, i.e., X2, Y2, Z2’’, indicates the required amount of water, i.e., Z2’’ at the location, i.e., (X2, Y2) in the field. Further, coordinates, i.e., X3, Y3, Z3’’, indicates the required amount of water content, i.e., Z3’’ at the location, i.e., (X3, Y3) in the field.

The controlling unit 114 may be configured to compute an amount of water content to be supplied to each of the plurality of intermediate locations and each of the plurality of locations in the field based on the field map, the first 3D-map, the second 3D-map, and the third 3D-map. In an embodiment, the map generating module 210 may compare the first 3D-map, the second 3D-map, and the third 3D-map with each other. The map generating module 210 may compute the amount of water content to be supplied at each location in the field by deducting the water retained in the field due to the plurality of environmental factors and the amount of water content present in the field from the required amount of water content for the type of plantation in the field.

The map generating module 210 may obtain the amount of water content present at a location in the field from the first 3D-map. Further, the map generating module 210 may obtain the amount of water retained in the field from the second 3D-map for the aforesaid location in the field. Furthermore, the map generating module 210 may obtain the required amount of water content from the third 3D-map for the aforesaid location in the field. Subsequently, the map generating module 210 may compute the amount of water content to be supplied at the aforesaid location in the field by deducting the amount of water content and the amount of water content retained in the field from the required amount of water content.

For instance, referring to Figure 4, Figure 5c, and Figure 7, the map generating module 210 may obtain the amount of water content, i.e., Z1, present at a location, i.e., (X1, Y1) from the first 3D-map. Further, the map generating module 210 may obtain the amount of water retained, i.e., Z1’, in the field corresponding to the location, i.e., (X1, Y1) from the second 3D-map. Furthermore, the map generating module 210 may obtain the required amount of water, i.e., Z1’’ at the location, i.e., (X1, Y1) from the third 3D-map. Subsequently, the map generating module 210 computes the amount of water content to be supplied at the location, i.e., (X1, Y1) in the field by deducting the amount of water content, i.e., Z1 and the amount of water content retained, i.e., Z1’ in the field from the required amount of water content, i.e., Z1’’. Similarly, the map generating module 210 may be configured to compute the amount of water content to be supplied at each location, i.e., the plurality of intermediate locations and the plurality of locations at which the sensors 116 are disposed in the field.

The controlling unit 114 may be configured to determine at least one portion of the field to be irrigated based on the amount of water content associated with each of the plurality of locations, the first set of data, and the second set of data. In an embodiment, the map generating module 210 may be configured to generate a fourth 3D-map indicating the amount of water content to be supplied based on the computed amount of water content to be supplied at each location in field.

Figure 8 illustrates an exemplary fourth 3D-map indicating the amount of water content to be supplied across the field, according to an embodiment of the present disclosure. Referring to Figure 8, an X-axis and a Y-axis of the fourth 3D-map collectively indicate an area of the field to be irrigated. Further, a Z-axis indicates the amount of water content to be supplied at different locations across the area of the filed. For instance, coordinates, i.e., X1, Y1, Z1''', indicates the amount of water, i.e., Z1''' to be supplied at the location, i.e., (X1, Y1), in the field. Similarly, coordinates, i.e., X2, Y2, Z2''', indicates the amount of water, i.e., Z2''' to be supplied at the location, i.e., (X2, Y2) in the field. Further, coordinates, i.e., X3, Y3, Z3''', indicates the amount of water content, i.e., Z3''' to be supplied at the location, i.e., (X3, Y3) in the field.

The controlling unit 114 may be configured to determine the at least one portion of the field to be irrigated based on the amount of water content to be supplied. As mentioned earlier, the map generating module 210 may be in communication with the location determining module 212. The map generating module 210 may transmit the fourth 3D-map indicating the amount of water content to be supplied across the field to the location determining module 212. In an embodiment, the location determining module 212 may determine the at least one portion of the field to be irrigated based on the amount of water content obtained from the fourth 3D-map.

Figure 9 illustrates an exemplary map depicting actuation of at least one sprinkler to irrigate at least one portion of the field, according to an embodiment of the present disclosure. The controlling unit 114 may be configured to actuate at least one of the sprinklers disposed in the vicinity of the determined portion of the field. In an embodiment, the location determining module 212 may identify at least one of the sprinklers disposed in the vicinity of the determined portion of the field based on the field map and the fourth 3D-map.

Referring to Figure 8 and Figure 9, for instance, the location determining module 212 may determine a location, i.e., (X1, Y1) in the field to be irrigated by supplying the amount of water content, i.e., Z1''' based on the fourth 3D-map. Subsequently, the location determining module 212 may identify at one of the sprinklers, i.e., 108-1 in the vicinity of the determined location, i.e., X1, Y1. The location determining module 212 may transmit an input indicative of operating the sprinkler 108-1 for supplying water content at the determined location, i.e., X1, Y1 to the irrigation system 102. Further, the controlling module 104 of the irrigation system 102 may actuate the solenoid valve 106-1 to allow the flow of water to the sprinkler 108-1 located at the determined location, i.e., X1, Y1.

In an embodiment, the controlling unit 114 may be configured to receive an input indicative of at least one of the location of plantation and the area of plantation. Further, the controlling unit 114 may be configured to generate a suggestion indicative of a number of sprinklers and a pattern of sprinklers to be positioned in the field based on the received input, the type of plantation, the location of plantation, the date of plantation, and the type of soil of plantation. In an embodiment, the controlling unit 114 may be configured to display the suggestion on the user interface of the autonomous sprinkler system 100.

Figure 10 illustrates a flowchart depicting a method 1000 of irrigating a field by an autonomous sprinkler system 100, according to an embodiment of the present disclosure. The method 1000 may be implemented in the autonomous sprinkler system 100 using components thereof, as described above. For the sake of brevity, details of the present disclosure that are explained in detail in the description of Figure 1, Figure 2, Figure 3, Figure 4, and Figures 5a, Figure 5b, Figure 5c, Figure 6, Figure 7, Figure 8, and Figure 9 are not explained in detail in the description of Figure 10.

At step 1002, the method 1000 includes receiving, by the controlling unit 114, information indicative of the amount of water content associated with each of the plurality of locations in the field from each of the plurality of sensors 116 disposed at the plurality of locations. Further, at step 1004, the method 1000 includes obtaining, by the controlling unit 114, the first set of data associated with the plurality of environmental factors and the second set of data associated with plantation in the field. In an embodiment, the plurality of environmental factors may include, but is not limited to, the precipitation, the atmospheric humidity, the daylight time, the wind speed, the rate of evaporation, the rate of infiltration, and the temperature associated with the field. Further, the first set of data may include, but is not limited to, the real-time value associated with each of the environmental factors and the forecast value associated with each of the environmental factors.

At step 1006, the method 1000 includes determining, by the controlling unit 114, at least one location from among the plurality of location in the field to be irrigated based on the amount of water content associated with each of the plurality of locations, the first set of data, and the second set of data. In an embodiment, the second set of data may include, but is not limited to, a type of plantation, a required amount of water content, a date of plantation, a type of soil of plantation, a location of plantation, an area of plantation, and data associated with fertigation. Further, at step 1008, the method 1000 includes actuating, by the controlling unit 114, at least one sprinkler disposed in vicinity of the determined location.

In an embodiment, the method 1000 includes determining the at least one portion of the field to be irrigated. Further, the method 1000 includes determining the plurality of locations at which the plurality of sensors 116 is disposed. The method 1000 includes obtaining a location of each of a plurality of sprinklers disposed in the field. Further, the method 1000 includes generating the field map indicating locations of each of the plurality of sensors 116, each of the plurality of sprinklers disposed in the field, and the area of influence associated with each of the plurality of sprinklers.

In an embodiment, the method 1000 includes obtaining the location of each of the plurality of sprinklers disposed in the field. The method 1000 includes receiving the input indicative of the location of each of the plurality of sprinklers disposed in the field. Further, the method 1000 includes determining the amount of water content associated with the plurality of intermediate locations in the field by interpolating the information received from the plurality of sensors 116. The method 1000 includes generating the first 3D-map indicating the amount of water content across the field at the plurality of intermediate locations and the plurality of locations of the plurality of sensors 116 based on the interpolation.

In an embodiment, the method 1000 includes determining the amount of precipitation in the field based on the first set of data associated with the environmental factors. Further, the method 1000 includes ascertaining the amount of water content evaporated from the field based on the first set of data associated with the plurality of environmental factors. The method 1000 includes computing the amount of water content retained at each of the plurality of intermediate locations and each of the plurality of locations in the field based on the difference between the amount of precipitation and the amount of water content evaporated. The method 1000 includes generating the second 3D-map indicating the amount of water content retained across the field.

In an embodiment, the method 1000 includes determining, based on the second set of data, the age associated with the type of plantation in the field and the required amount of water content at the determined age of the type of plantation. Further, the method 1000 includes generating the third 3D-map indicating the required amount of water content for the type of plantation at the determined age across the field. The method 1000 includes computing the amount of water content to be supplied to each of the plurality of intermediate locations and each of the plurality of locations in the field based on the field map, the first 3D-map, the second 3D-map, and the third 3D-map. The method 1000 includes determining the at least one portion of the field to be irrigated based on the amount of water content to be supplied.

In an embodiment, the method 1000 includes receiving the input indicative of selection of the type of plantation from among the plurality of plantations and the input indicative of the date of plantation associated with the selected type of plantation. The method 1000 includes obtaining, from the pre-stored data, the required amount of water content associated with the selected type of plantation. The pre-stored data includes the required amount of water content corresponding to each of the plurality of plantations.

In an embodiment, the method 1000 includes receiving the input indicative of at least one of the location of plantation and the area of plantation. Further, the method 1000 includes generating the suggestion indicative of the number of sprinklers and the pattern of sprinklers to be positioned in the field based on the received input, the type of plantation, the location of plantation, the date of plantation, and the type of soil of plantation.

At least by virtue of aforesaid embodiment, the present disclosure at least leads to the following advantages:

1. The plurality of environmental factors, such as current weather conditions and weather forecast for possible precipitation and evaporation, is considered while computing the amount of water content required for irrigating the field.

2. The contouring of the water content in the soil at different locations in the field is determined to provide a regular amount of water content to the whole field with respect to the type of plantation.

3. The Pre-stored database is provided to retrieve information regarding the requirement of irrigation, such as the required amount of water content, by a particular type of crop at different stages, such as life span of the crop.

4. Regular monitoring of all parameters, such as the environmental factors and accounting all values, such as the amount of water content present at different locations in the field, is performed by the autonomous sprinkler system 100 for further reference and to improve the overall yield of the crop across the field.

5. Precise contouring the water output from each sprinkler to provide more accurate irrigation to the area in a range of one sprinkler and irrigating the intersection of an area in the range of two or more sprinklers.

6. The autonomous sprinkler system 100 and the irrigation system 102 can be remotely monitored and controlled.

While specific language has been used to describe the present subject matter, any limitations arising on account thereto, are not intended. As would be apparent to a person in the art, various working modifications may be made to the method in order to implement the inventive concept as taught herein. The drawings and the foregoing description give examples of embodiments. Those skilled in the art will appreciate that one or more of the described elements may well be combined into a single functional element. Alternatively, certain elements may be split into multiple functional elements. Elements from one embodiment may be added to another embodiment.

[redacted]

[redacted]

[redacted]

[redacted]

Abstract Of The Invention

AN AUTONOMOUS SPRINKLER SYSTEM AND A METHOD FOR IRRIGATION IN A FIELD

An autonomous sprinkler system for irrigation in a field is disclosed. The autonomous sprinkler system includes a plurality of sensors disposed at a plurality of locations in the field. Each of the plurality of sensors is adapted to measure an amount of water content associated with a location from among the plurality of locations. The autonomous sprinkler system may include a controlling unit configured to receive information indicative of the amount of water content associated with each of the plurality of locations from each of the plurality of sensors. The controlling unit is configured to obtain a first set of data associated with a plurality of environmental factors and a second set of data associated with plantation in the field. The controlling unit is configured to determine at least one portion of the field to be irrigated based on the amount of water content, the first set of data, and the second set of data. Further, the controlling unit is configured to actuate at least one sprinkler disposed in vicinity of the determined portion of the field.

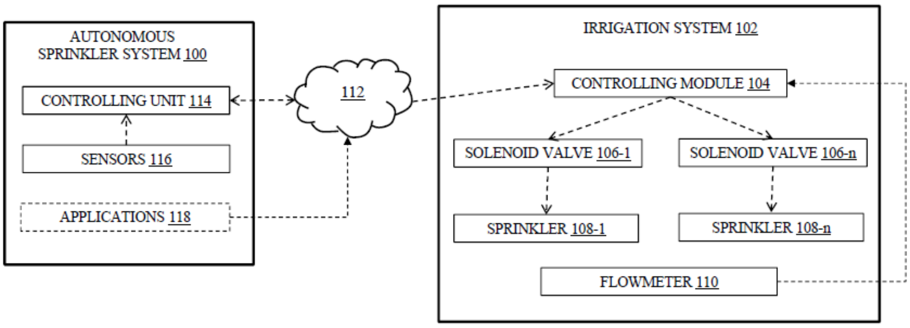

FIGURE 1

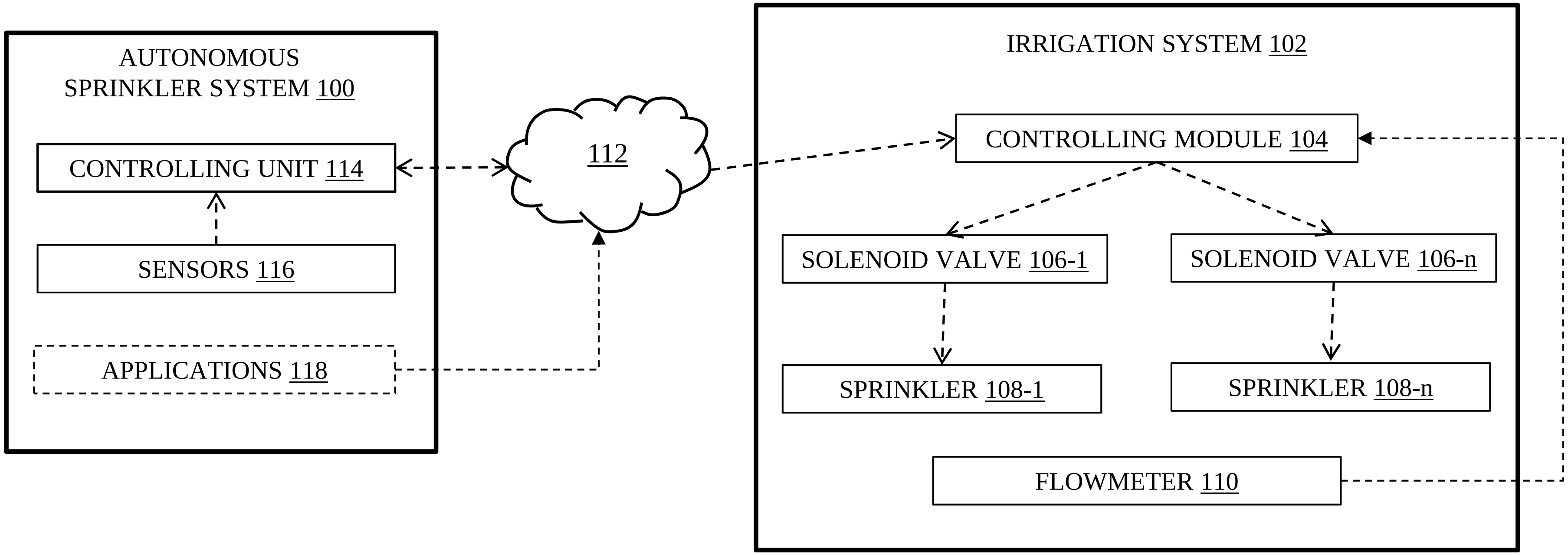
AUTONOMOUS SPRINKLER SYSTEM 100
CONTROLLING UNIT 114
SENSORS 116
APPLICATIONS 118
112
IRRIGATION SYSTEM 102
CONTROLLING MODULE 104
SOLENOID VALVE 106-1
SOLENOID VALVE 106-n
SPRINKLER 108-1
SPRINKLER 108-n
FLOWMETER 110

FIGURE 1

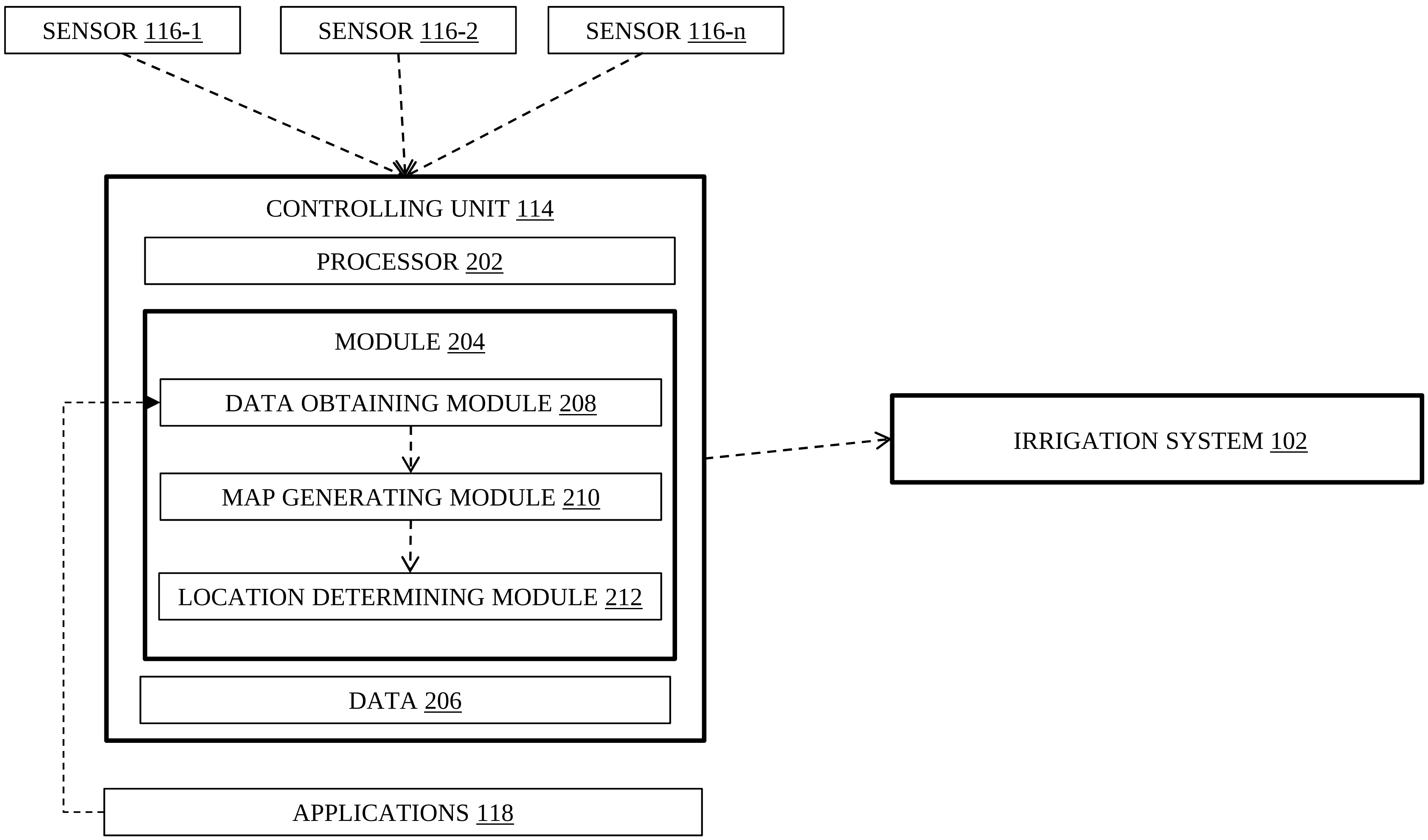

FIGURE 2

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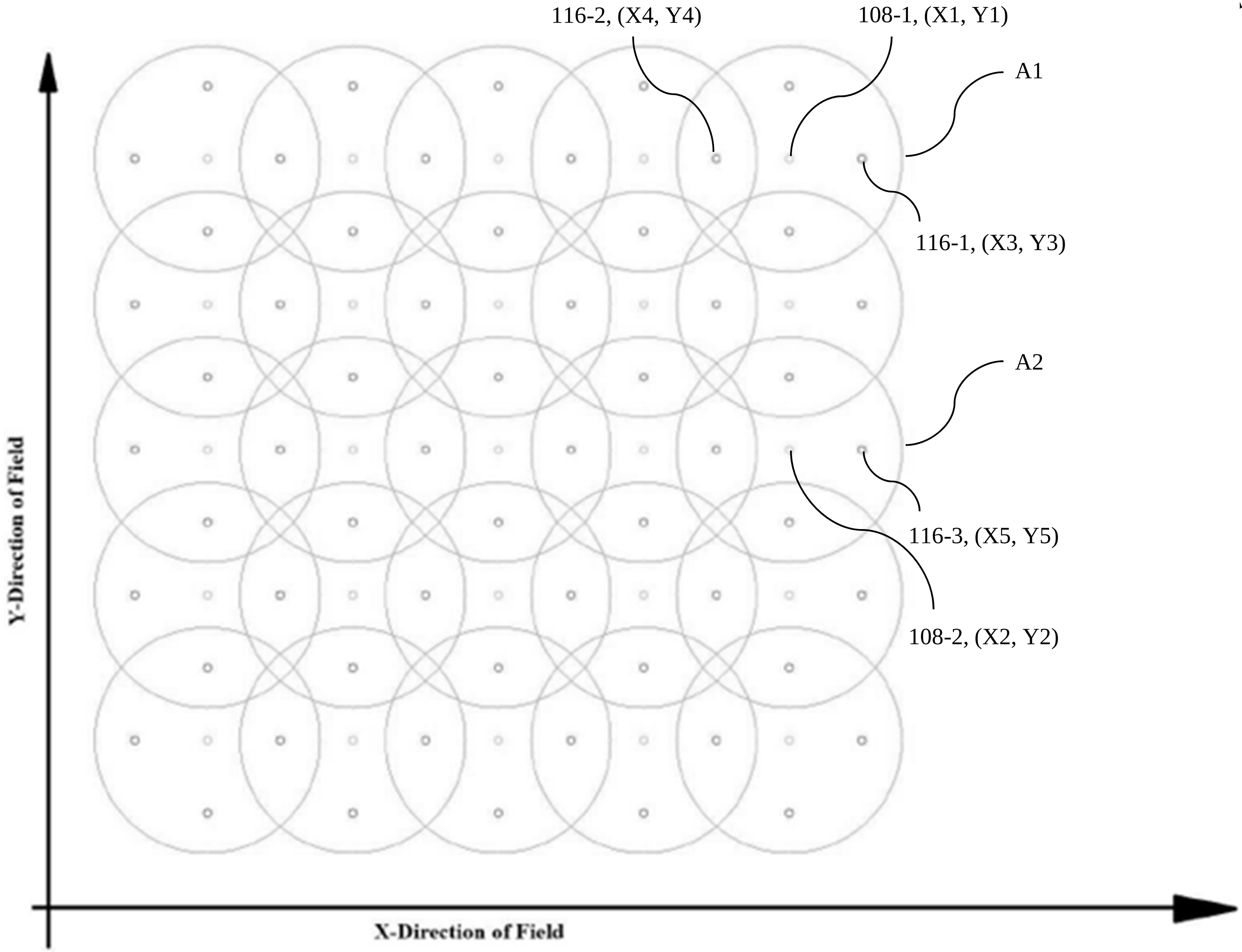

FIGURE 3

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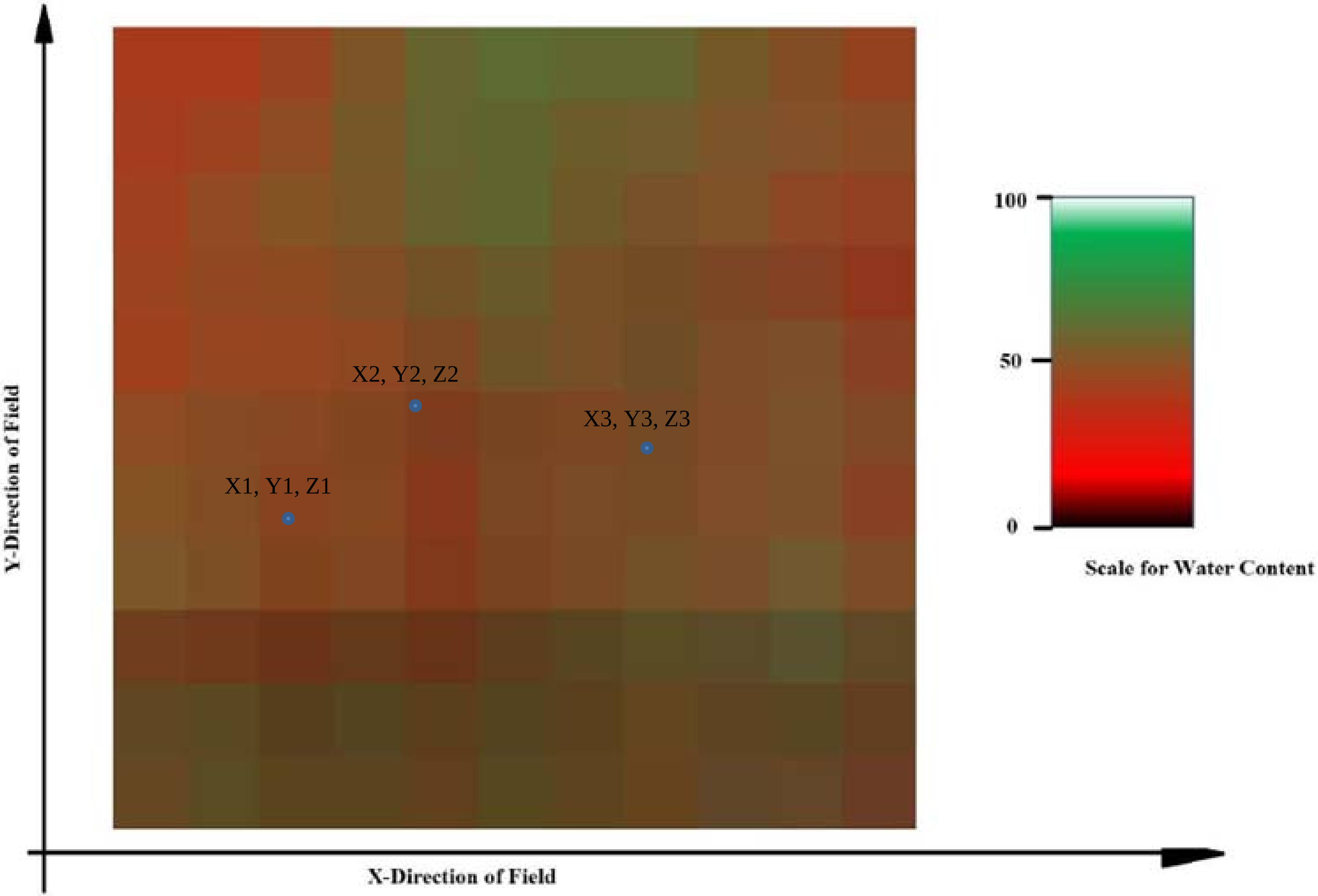
X2, Y2, Z2
X3, Y3, Z3
X1, Y1, Z1
Y-Direction of Field
X-Direction of Field
100
50
0
Scale for Water Content

FIGURE 4

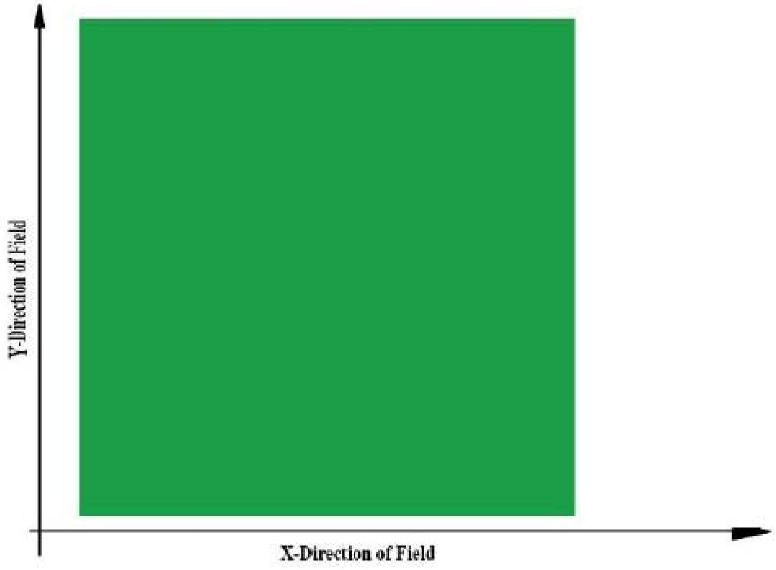

FIGURE 5a

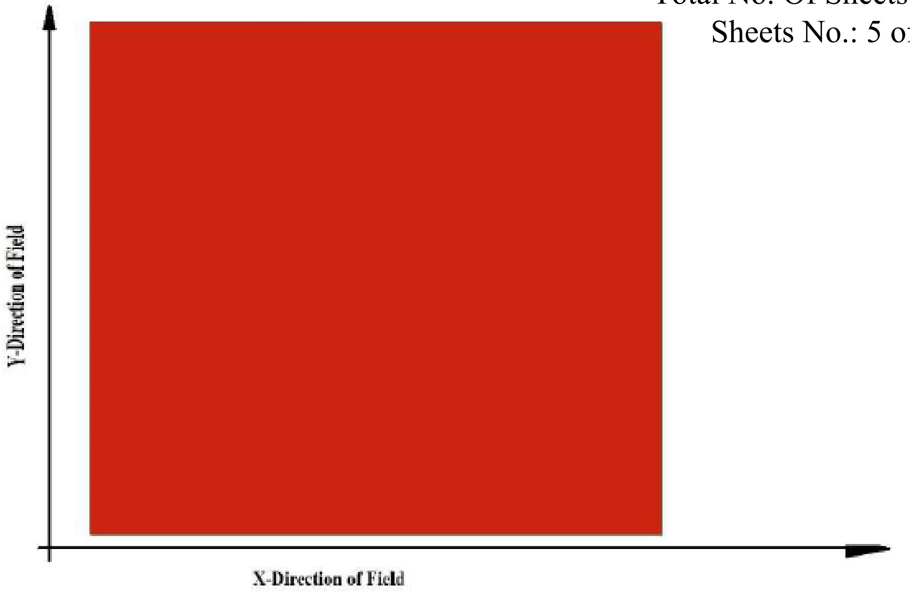

FIGURE 5b

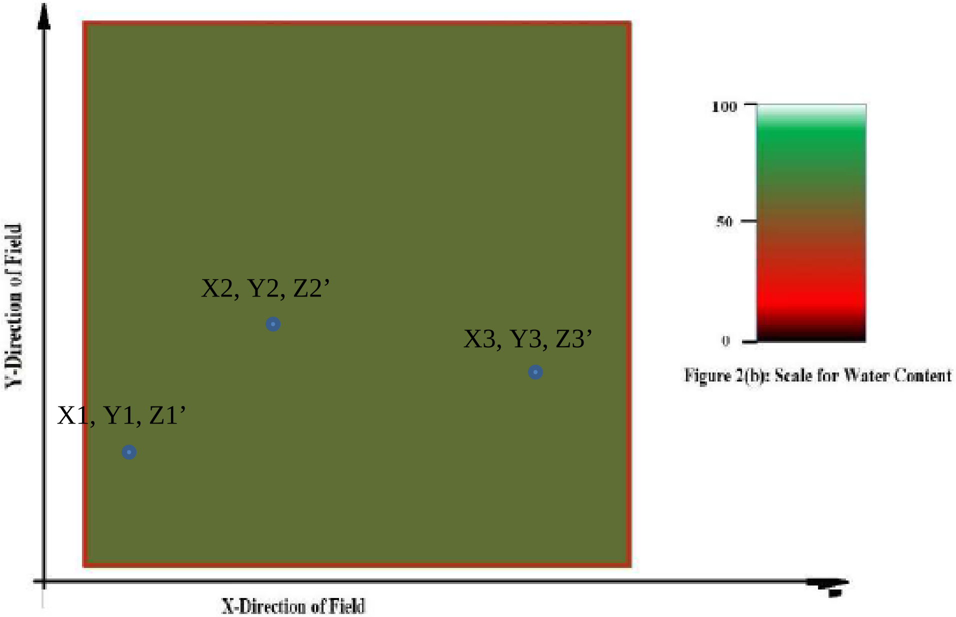

FIGURE 5c

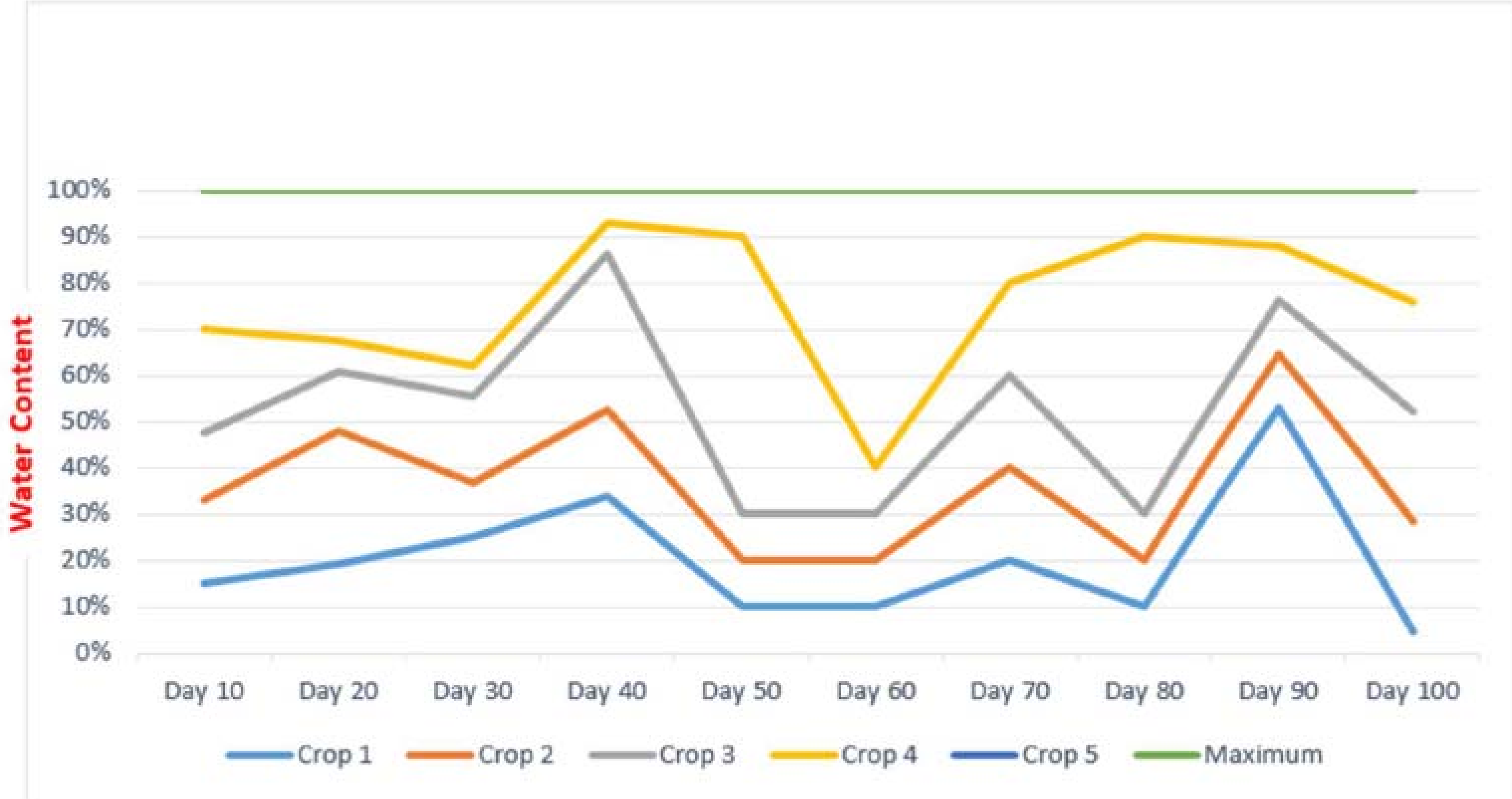

FIGURE 6

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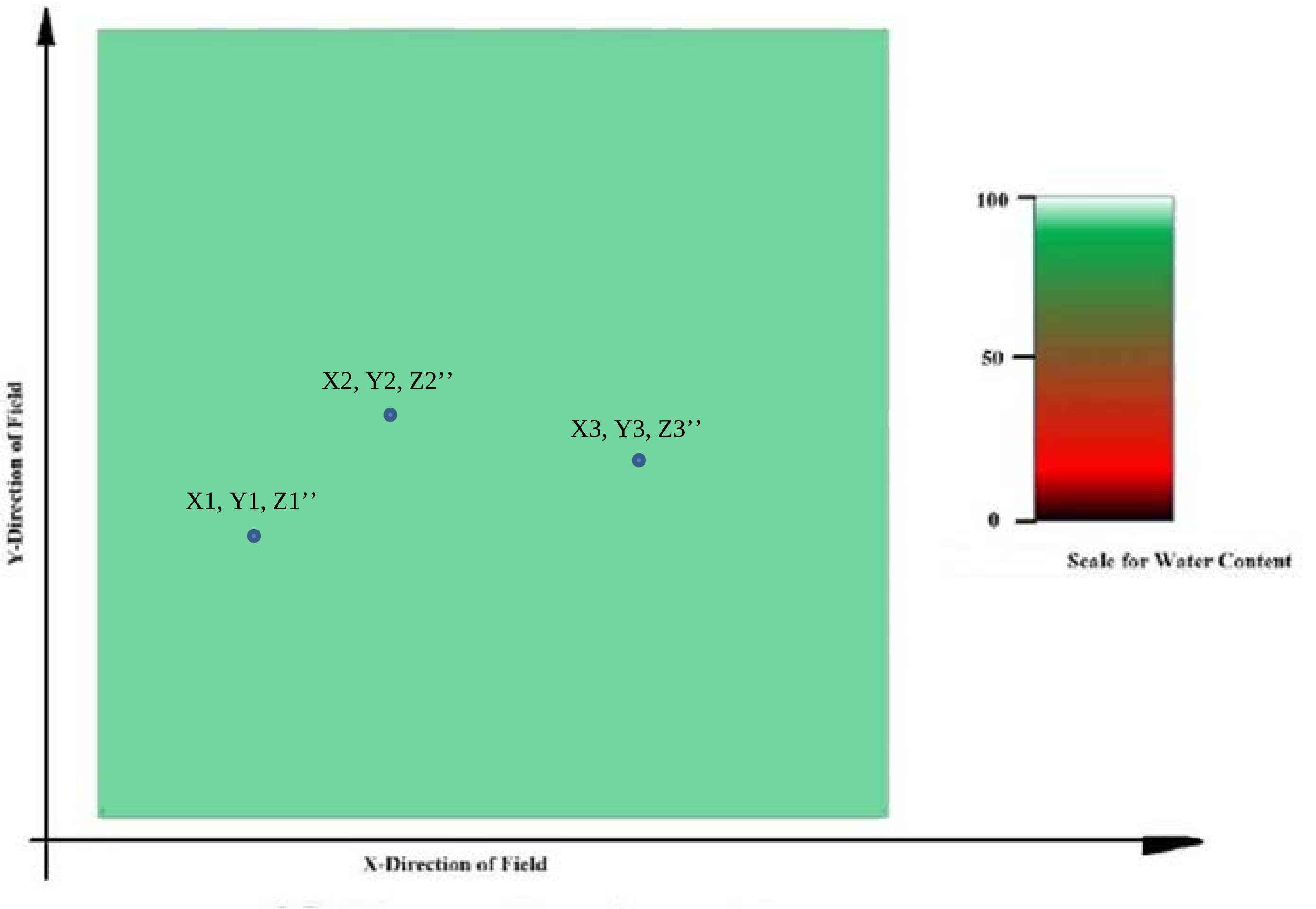
X2, Y2, Z2''
X3, Y3, Z3''
X1, Y1, Z1''
Y-Direction of Field
X-Direction of Field
100
50
0
Scale for Water Content

FIGURE 7

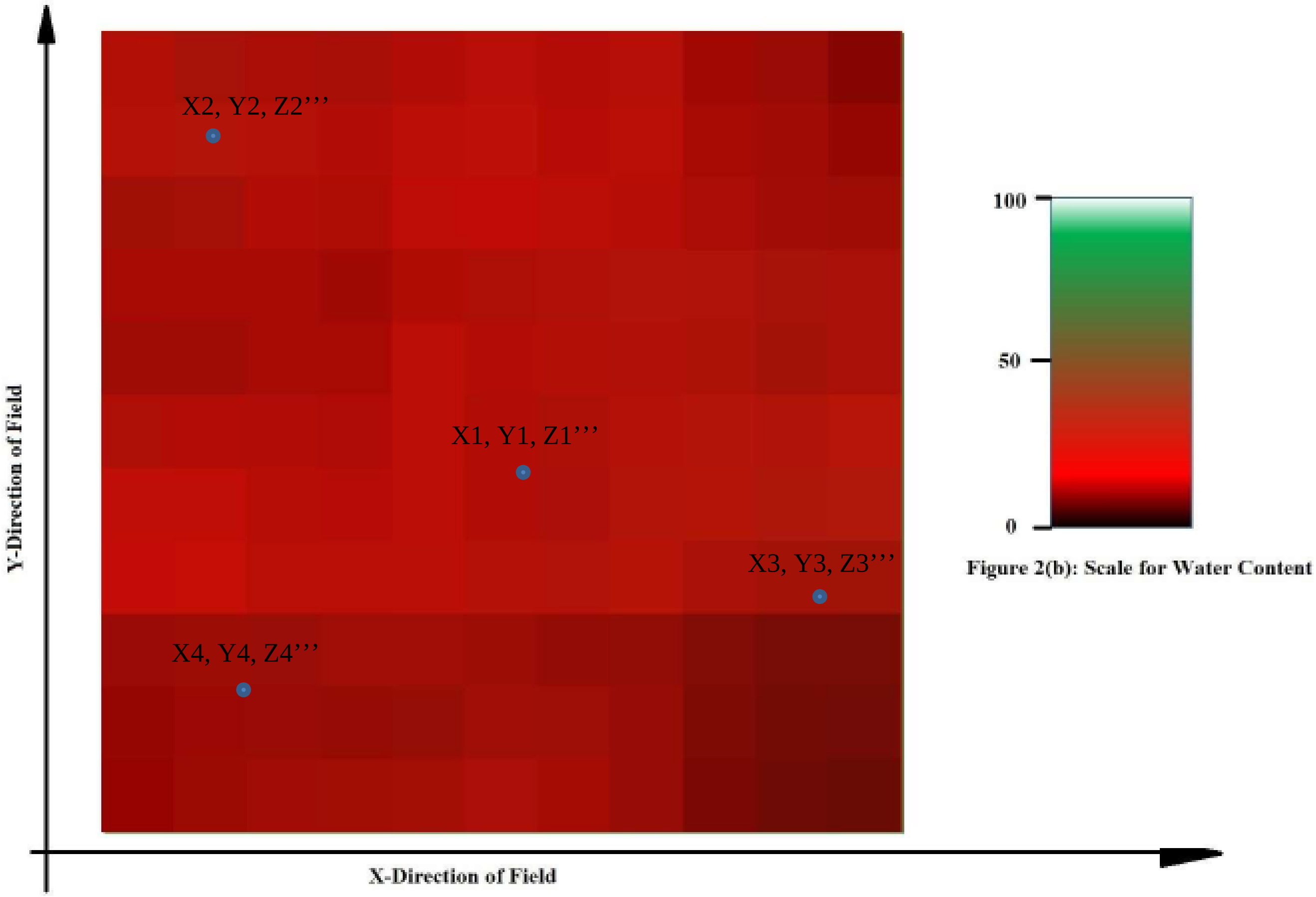

FIGURE 8

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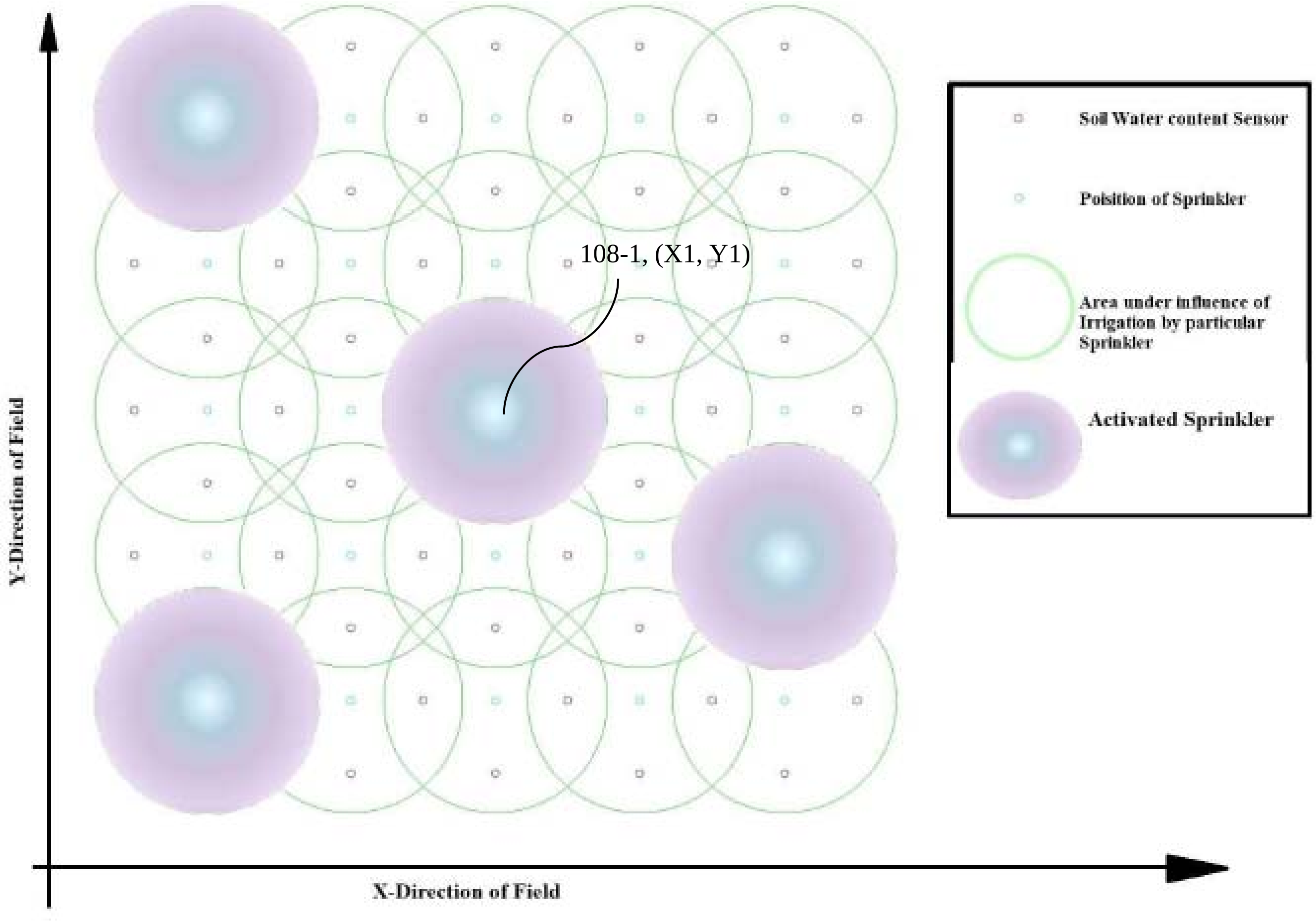
108-1, (X1, Y1)
Soil Water content Sensor
Poisition of Sprinkler
Area under influence of Irrigation by particular Sprinkler
Activated Sprinkler
Y-Direction of Field
X-Direction of Field

FIGURE 9

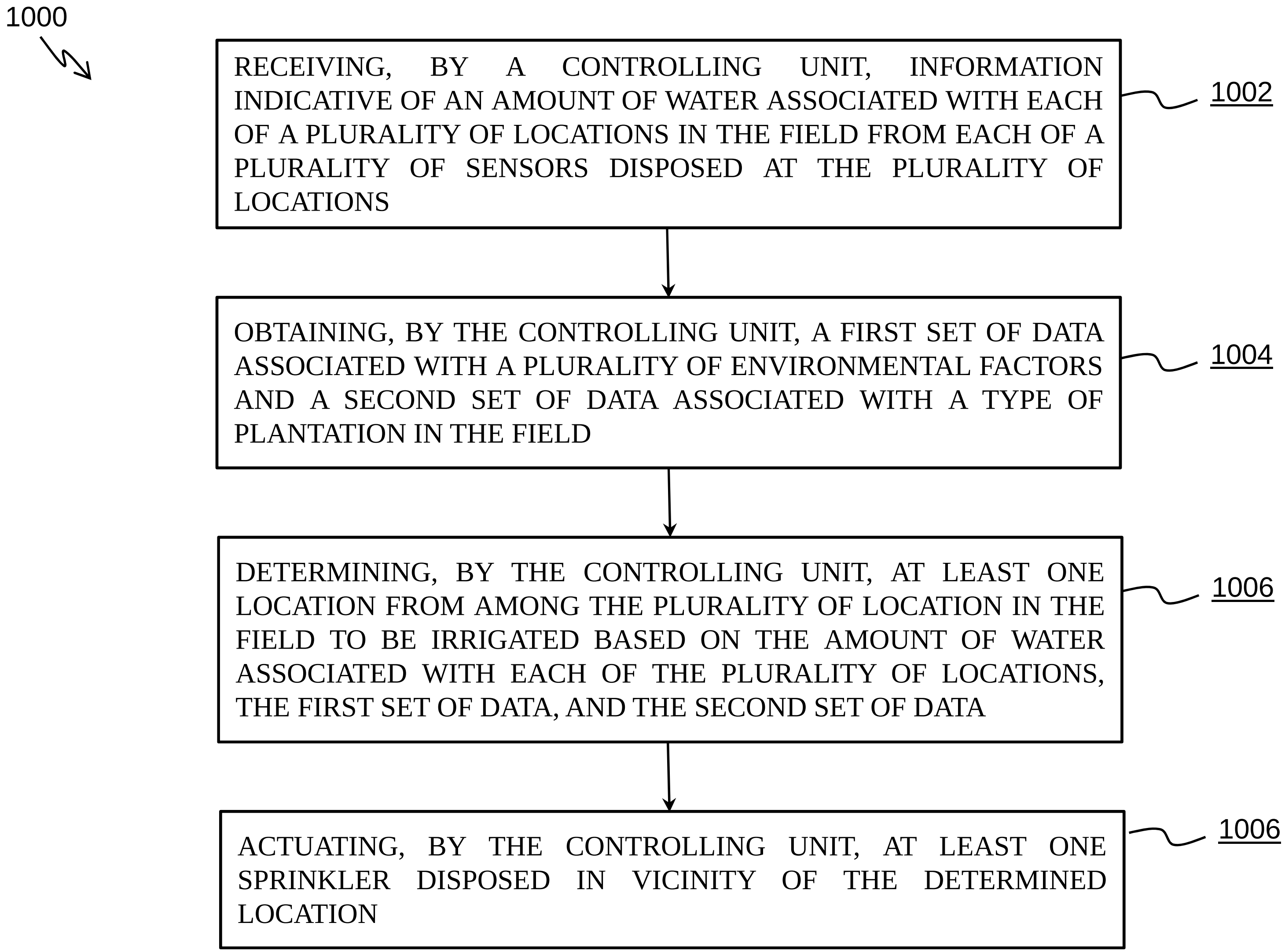

FIGURE 10

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