(12) STANDARD PATENT (11) Application No. **AU 2009201226 B2**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
System and method for collecting data in a banana patch

(51) International Patent Classification(s)
G06F 19/00 (2011.01) ***G01S 5/00*** (2006.01)
A01G 17/00 (2006.01) ***G06Q 50/00*** (2006.01)

(21) Application No: **2009201226** (22) Date of Filing: **2009.03.30**

(43) Publication Date: **2010.10.14**
(43) Publication Journal Date: **2010.10.14**
(44) Accepted Journal Date: **2011.11.03**

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(56) Related Art
US 2003/0182022 A1
ROBINSON, J et al, 'Forecasting of banana harvest (`Williams') in the subtropics using seasonal variations in bunch development rate and bunch mass', Scientia Horticulturae, Volume 34, Issues 3-4, February 1988, Pages 249-263
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ABSTRACT

Embodiments of the invention are enabled by individually tagging each banana tree and recording a position for each banana tree. Selected suckers may also be tagged and associated with their parent trees. In another respect, embodiments of the invention provide a handheld device that allows a human operator to record events and/or receive data that is pertinent to banana cultivation. The handheld device may also interface with a broader information system.

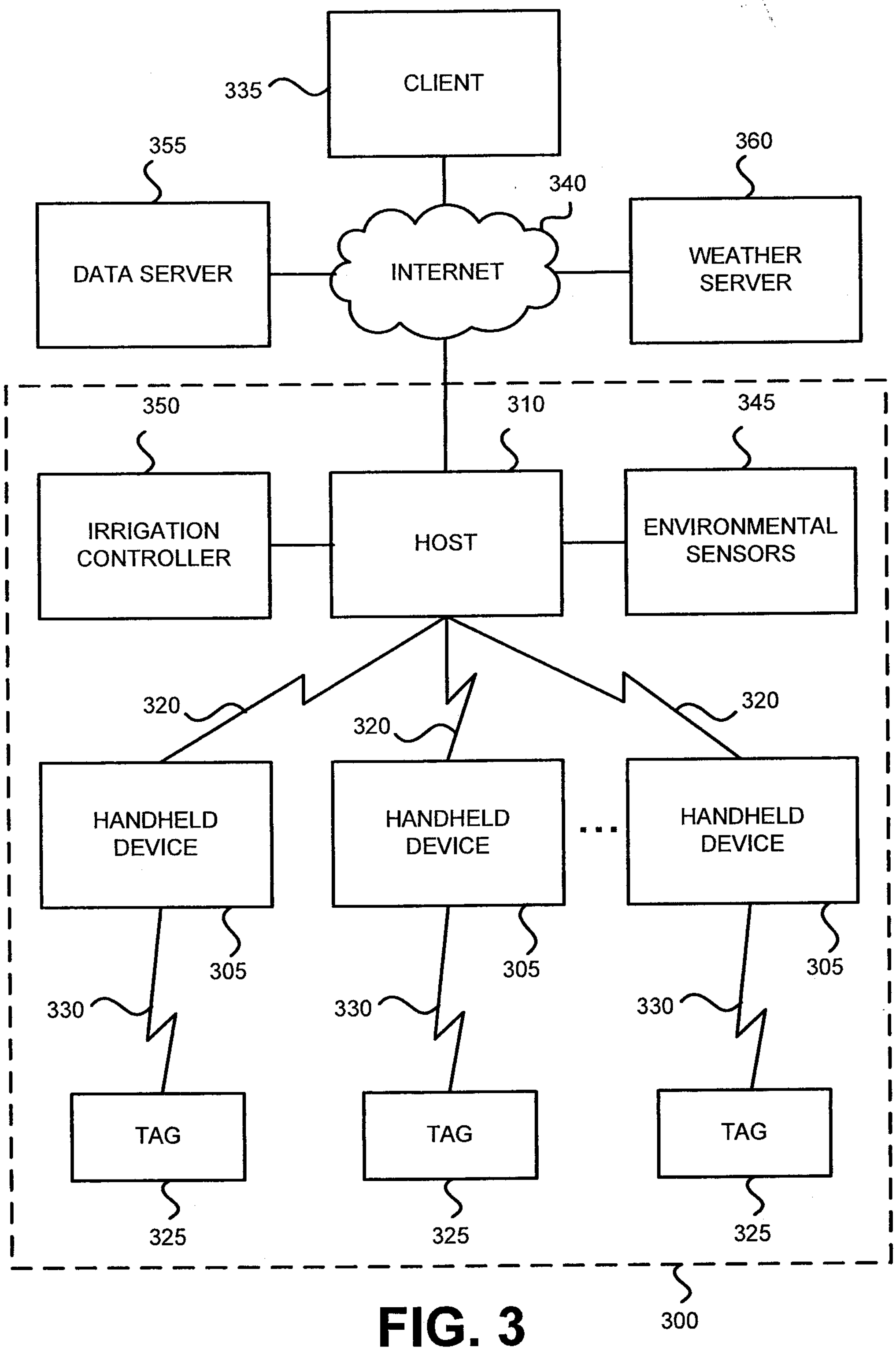
CLIENT
335
355
360
340
DATA SERVER
INTERNET
WEATHER SERVER
350
310
345
IRRIGATION CONTROLLER
HOST
ENVIRONMENTAL SENSORS
320
320
320
HANDHELD DEVICE
HANDHELD DEVICE
HANDHELD DEVICE
305
305
305
330
330
330
TAG
TAG
TAG
325
325
325
300

FIG. 3

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AUSTRALIA

Patents Act of 1990

COMPLETE SPECIFICATION
STANDARD PATENT

Applicant: **SCOTT MUNRO**

Invention Title: **SYSTEM AND METHOD FOR COLLECTING DATA IN A BANANA PATCH**

The following statement is a full description of this invention, including the best method of performing it known to me:

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SYSTEM AND METHOD FOR COLLECTING DATA IN A BANANA PATCH

BACKGROUND

1. Field of the Invention

[0001] The invention relates generally to data collection and processing, and more particularly, but without limitation, to a system and method for collecting data in a banana patch. Embodiments of the invention also relate to systems and methods that exploit the collected data.

2. Description of the Related Art

[0002] Data collection systems have been applied to agriculture. Known data collection systems have many shortcomings, however. For instance, one class of data-collection systems is focused on post-harvest activities. Such systems are specifically adapted to provide chain-of-custody information by tracking produce or other food products from the farm through storage, distribution, and/or sales channels. Accordingly, systems of this class may do little to improve a grower's productivity.

[0003] Other known data collection systems enable so-called precision farming applications. In accordance with conventional precision-farming techniques, crop conditions are determined via sampling or overhead imaging. For instance, a farmer may extract wheat samples from a north-west corner of his field for analysis. Alternatively, a farmer may analyze his crops using satellite images. The determined crop conditions may then be addressed by automated farming equipment. For example, the health of the crop sample may inform the rate at which fertilizer is applied in the north-west corner of the wheat field.

[0004] Unfortunately, the nature of banana production is that bunches develop and mature rather uniquely on each banana plant (tree). Accordingly, field sampling techniques are not effective in scheduling cultivation tasks or in predicting harvest in a banana patch. Because banana bunches grow beneath banana tree canopies, overhead imaging assets are not effective. Moreover, nearly all cultivation tasks in a banana patch are performed by manually. For these and other reasons, improved precision farming systems and methods are needed for producing bananas.

SUMMARY OF THE INVENTION

[0005] Embodiments of the invention seek to overcome one or more of the shortcomings described above. In one respect, embodiments of the invention are enabled by individually tagging each banana tree. Selected suckers may also be tagged and associated with their parent trees, as will be described in more detail below. In another respect, embodiments of the invention provide a handheld device that allows a human operator to record events and/or receive data that is pertinent to banana cultivation. The handheld device may also interface with a broader information system.

[0006] More specifically, an embodiment of the invention provides a method for collecting data in a banana patch. The method includes: receiving a tree identifier; creating a tree identification record in a memory; determining whether position data exists for the tree identifier; and if position data exists for the tree identifier, appending the tree identification record with the position data.

[0007] Yet another embodiment of the invention provides a system that includes: a host computer; at least one handheld device configured to couple to the host computer; and a plurality of tags configured to be read by the tag reader, each of the plurality of tags affixed to a corresponding one of a plurality of banana trees in a banana patch. The handheld device may include: a processor; a tag reader coupled to the processor; and a Global Positioning System (GPS) receiver coupled to the processor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The invention will be more fully understood from the detailed description below and the accompanying drawings, wherein:

[0009] Fig. 1 is an elevation view of a banana tree;

[0010] Fig. 2 is a plan view of a banana patch, according to an embodiment of the invention;

[0011] Fig. 3 is a functional block diagram of a data collection system, according to an embodiment of the invention;

[0012] Fig. 4 is a functional block diagram of a handheld device, according to an embodiment of the invention;

[0013] Fig. 5 is a plan view of a barcode tag, according to an embodiment of the

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invention;

[0014] Fig. 6 is an illustration of a graphical user interface (GUI), according to an embodiment of the invention;

[0015] Fig. 7 is an illustration of a menu system for the graphical user interface of Fig. 6, according to an embodiment of the invention;

[0016] Fig. 8 is a flow diagram of a tagging process, according to an embodiment of the invention;

[0017] Fig. 9 is a flow diagram of a tagging process, according to another embodiment of the invention;

[0018] Fig. 10 is a flow diagram of an adoption process, according to an embodiment of the invention;

[0019] Fig. 11 is a flow diagram of an adoption process, according to an embodiment of the invention;

[0020] Fig. 12 is a flow diagram of an information display process, according to an embodiment of the invention;

[0021] Fig. 13 is a flow diagram of an information display process, according to an embodiment of the invention;

[0022] Fig. 14 is an illustration of a graphical user interface, according to an embodiment of the invention;

[0023] Fig. 15 is a functional block diagram of a skipping application, according to an embodiment of the invention;

[0024] Fig. 16 is flow diagram of a skipping process, according to an embodiment of the invention;

[0025] Fig. 17 is a functional block diagram of a bunch harvest forecasting application, according to an embodiment of the invention; and

[0026] Fig. 18 is a flow diagram of a bunch harvest forecasting process, according to an embodiment of the invention.

DETAILED DESCRIPTION

[0027] The invention will now be described more fully with reference to Figs. 1-18, in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. In the drawings, reference designators may be duplicated for the same or similar features. The figures are not drawn to scale; some features may be exaggerated for clarity.

[0028] Fig. 1 is an elevation view of a banana tree. Strictly speaking, bananas grow on plants that are members of the herbaceous family (herbs). And banana plants lack woody tissue. Nevertheless, banana plants are commonly referred to as trees, and that same term will be used herein.

[0029] As shown in Fig. 1, a banana tree typically includes a pseudo-stem 105, multiple leaves 110, a bunch 120, and a flower or bell 115 attached to an end of the bunch 120. A mature bunch 120 usually includes several (e.g., 3-20) hands (tiers); each hand includes multiple fingers (bananas).

[0030] A banana tree typically produces a single bunch in its lifetime. After that, the banana tree will die. New banana trees are propagated by pups or suckers that share a common stool with the parent tree. In Fig. 1, the (parent) tree that is defined by pseudo-stem 105 shares a common stool (not shown) with the sucker 125. Although several suckers may emerge from the stool, cultivation practices require that a predetermined number of suckers are selected to replace the parent tree. For instance, a new patch may be planted at one-third the ultimate patch density so that three suckers are selected for growth. Alternatively, a patch may be planted at its ultimate desired density such that only a single sucker is selected for growth. Embodiments of the invention recognize the importance of this selection practice by creating and exploiting a data association between a parent tree and its selected sucker(s).

[0031] Fig. 2 is a plan view of a banana patch, according to an embodiment of the invention. As shown therein, a banana patch 200 may be organized into rows 205, 210, and 215. Each of the rows 205, 210, and 215 may include multiple banana trees. In embodiments of the invention, each of the rows 205, 210, and 215 may be assigned a unique row identifier (row ID). Each of the trees may be assigned a unique tree identifier (tree ID). Preferably, a data record for each tree ID preferably includes a reference to a corresponding row ID.

[0032] The position of an individual banana tree 220 may be expressed according to one or more alternative schemes. For example, banana tree 220 may be identified as the 3rd (third) banana tree from a first end of row 210. Alternatively, banana tree 220 may be described as being located at a distance d from the first end of the row 210. Optionally, the banana tree 220 can be addressed according to its geographic coordinates (e.g., a longitude and latitude). Other relative coordinate systems could also be used, according to design choice.

[0033] Fig. 3 is a functional block diagram of a data collection system, according to an embodiment of the invention. As shown therein, a patch system 300 may include a host computer 310. The host computer 310 may be physically located external to a patch, for example in a plantation office. The host computer 310 may be configured to couple to one or more handheld devices 305 via link 320. Link 320 may be or include, for example, a relatively short-range communications protocol such as a wired Universal Serial Bus (USB) connection, a wireless Bluetooth™ connection, a wired serial connection, a Local Area Network, or an infrared connection. The relatively short-range communications protocol may be appropriate, for instance, for batch synchronization between the host 310 and handheld devices 305. Alternatively, link 320 may be or include a relatively long-range communication protocol such as a Universal Mobile Telecommunication System (UMTS) or General Packet Radio Service (GPRS) connection. The relatively long-range communications protocol may better-suited, for example, for near real-time synchronization between the host 310 and handheld devices 305.

[0034] Each of the handheld devices 305 may be configured to read tags 325 via link 330. The link 330 may be related to the particular type of tag 325 that is utilized. For example, where the tag 325 is a Radio Frequency Identification (RFID) tag, the link 330 may be or include a wireless RF connection. In an alternative embodiment of the invention, tags 325 may include barcode symbols; in this instance, the link 330 may be or include light transmission and reflection according to known light-emitting diode (LED) wand, laser-scanning, optical imaging, or other barcode-reading techniques. Preferably, each of the handheld devices 305 can read each of the tags 325. Exemplary embodiments of the handheld device 305 and tag 325 are described below with reference to Figs. 4 and 5, respectively.

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[0035] The host computer 310 may be coupled to one or more environmental sensors 345. The environmental sensors 345 may be or include, for example, a wind gauge, a rain gauge, a thermometer, a hygrometer, or other environmental sensors that are proximate to the patch. The host computer 310 may also be coupled to an irrigation controller 350. The irrigation controller 350 may control the delivery of irrigation to the patch. Accordingly, the irrigation controller 350 may provide information to the host computer 310 such as the date, time, location, and duration of applied irrigation.

[0036] The host computer 310 may also be coupled to networks and resources external to the patch system 300. For instance, the host 310 may be coupled to one or more of a client 335, data server 355, and/or a weather server 360 via the internet 340 or other network(s). The client 335 may access data on the host computer 310, data server 355, and/or weather server 360. The data server 355 may include data collected by one or more instances of the patch data collection system 300, and may be used to host a data reporting utility. The weather server 360 may include, for example, weather data such as daily high temperature, daily low temperature, daily maximum wind speed, or other weather data. Advantageously, data from the weather server 360 may be merged with non-weather data residing in the host computer 310 and/or the data server 355. It should be appreciated that the environmental sensors 345 and the weather server 360 may be used in the alternative or in complimentary fashion.

[0037] Variations to the functional block diagram illustrated in Fig. 3 are possible. For example, the host 310, the client 335, the internet 340, the environmental sensors 345, the irrigation controller 350, the data server 355, and the weather server 360 are each optional features that can be used in any combination with the handheld devices 305 and tags 325.

[0038] In an alternative embodiment, the environmental sensors 345 may be linked to the handheld devices 305 rather than the host 310. In embodiments where the patch system 300 does not include a host 310, each of the handheld devices may be coupled to a remotely-located data server 355 via a link that supports a relatively long-range communication protocol.

[0039] Fig. 4 is a functional block diagram of a handheld device, according to an embodiment of the invention. The handheld device 305 illustrated in Fig. 4 is one

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embodiment of the handheld device 305 shown in Fig. 3. As shown Fig. 4, the handheld device 305 may include a processor 405 coupled to a memory system 410 via a memory bus 415. The memory system 410 preferably includes a combination of volatile and non-volatile memory. The volatile memory portion of the memory system 410 may be or include Random Access Memory (RAM). The non-volatile portion of the memory system 410 may store an operating system (OS) 420, application code 425, and a database 430. The processor 405 may further be coupled to Input/Output (I/O) devices 435 via an I/O bus 440. The I/O devices 435 may include, for instance, a display 445, a keypad 450, a tag reader 455, a Global Positioning System (GPS) receiver 460, and a transceiver (XCVR) 465.

[0040] In one embodiment of the invention, the application code 425 is a relatively simple logging routine; in other embodiments, the application code 425 is configured to provide a Graphical User Interface (GUI) to an operator and implement relatively sophisticated data collection and/or display logic as further described below with reference to Figs. 6, 7, 9, 11, 13, and 14.

[0041] The tag reader 455 may be or include, for example, an RFID transceiver, a laser barcode scanner, an Optical Character Recognition (OCR) device, and/or an optical pattern recognition device. The XCVR 465 may be or include a USB Interface (I/F), a wireless Bluetooth™ device, a serial I/F, a LAN I/F, an infrared communication I/F, or another relatively short-range transceiver. Alternatively, or in combination, the XCVR 465 may be or include a relatively long-range communication transceiver such as a UMTS or GPRS communication device.

[0042] In operation, the processor 405 may execute the application code 425 to receive data from the keypad 450, tag reader 455, GPS receiver 460, and/or XCVR 465. The processor 405 may also be configured by the application code 425 to output messages to the display 445. The processor 405 may also output data and/or commands via the XCVR 465. The database 430 may store data received from the keypad 450, tag reader 455, GPS receiver 460, and/or XCVR 465.

[0043] Variations to the configuration illustrated in Fig. 4 and described above are possible. For example, where the handheld device 305 maintains communication with the host 310 and/or data server 355, the application code 425 may be stored and executed on the host 310 and/or data server 355, respectively, instead of on the handheld device 305. In alternative embodiments, data could be stored in the memory system 410 without the use of a database 430. The display 445 may be or include a touch-sensitive screen that is configured to receive data from an operator; in this instance, the keypad 450 may not be required. In an alternative embodiment, the handheld device 305 may not include the GPS receiver 460. Various power supply and power conditioning components can be included in the handheld device 305 according to design choice. The handheld device 305 may include a microphone, and the application code 425 may include voice-recognition software. Together, the microphone and voice-recognition software could thus enable an additional channel for data collection from an operator. A speaker could be included in the handheld device 305 to output audible prompts that are generated by the application code 425.

[0044] Preferably, the handheld device 305 is ruggedized, compact, and portable to facilitate the collection of event data in a banana patch by human operators. A Honeywell Dolphin® 9900 Mobile Computer is an exemplary handheld device 305. Windows Mobile® by Microsoft Corporation is an exemplary OS 420.

[0045] Fig. 5 is a plan view of a barcode tag, according to an embodiment of the invention. The barcode tag 500 illustrated in Fig. 5 is an exemplary embodiment of the tag 325.

[0046] As shown in Fig. 5, the barcode tag 500 may include a pointed end 505 that is configured for insertion into the pseudo-stem 105 of a banana tree. The pointed end 505 may also include an aperture 510 so that the barcode tag 500 could be hung on a hook or attached to a pseudo-stem via string or wire. In the illustrated embodiment, the barcode tag 500 further includes a barcode 515, a human-readable portion 520, and a grower identification number 525. Alternative encodings may be used for the barcode 515. For example, the barcode 515 may be compliant with Code 2/5 interleaved, Code 3 of 9, Code 93, Code 128, Codabar, or other bar code specification. The human-readable portion 520 is a decoded representation of the barcode 515.

[0047] In use, a grower may use barcode tags 500 to identify rows, trees, and suckers. In alternative embodiments, a grower may use barcode tags 500 to identify patches and/or stools. To distinguish a row ID tag from a tree ID tag, a prefix such as

"R" may be added to the grower identification number 525 in the case of a row ID tag. In embodiments of the invention, no two barcode tags 500 in a patch include identical barcodes 515. Preferably, each barcode tag 500 is resistant to environmental conditions such as water, ultraviolet (UV) rays, and banana tree sap.

[0048] Fig. 6 is an illustration of a Graphical User Interface (GUI), according to an embodiment of the invention. The GUI 605 may be presented on the display 445 of the handheld device 305. As shown in Fig. 6, a GUI 605 may include a status portion 610, a data portion 615, and a toolbar 620. The status portion 610 may display, for instance, the active event, current operator, active row, active tree, and/or current position. The current operator is the operator currently logged onto the handheld device 305. The current position may be, for example, near real-time coordinates provided by the GPS receiver 460.

[0049] The toolbar portion 620 may include one or more buttons 625. In embodiments of the invention, an operator can navigate the GUI 605 and select a button 625 on the toolbar 620 via arrow keys on the keypad 450. Alternatively, and operator may key the keypad 450 to make selections using shortcut keys. Alternatively, or in combination, an operator may interact with the GUI 605 using a touch-sensitive feature of the display 445. In yet another embodiment, the GUI 605 may be responsive to commands entered by an operator using a microphone and voice-recognition software. Other variations to the GUI 605 illustrated in Fig. 6 are possible. For example, in an alternative embodiment, a text region may be included between the status portion 610 and the data portion 615.

[0050] Fig. 7 is an illustration of a menu system for the GUI 605, according to an embodiment of the invention. The toolbar 710 is a particular instance of the toolbar 620. The toolbar 710 includes select event button 705.

[0051] In the illustrated embodiment, a menu 715 is displayed in response to the selection of the select-event button 705. The menu 715 includes multiple events associated with banana production. Table 1 below lists the name, shortcut key, and a brief description of each event listed in menu 715.

EVENT	SHORTCUT KEY	BRIEF DESCRIPTION
Adopt	A	Associate an active sucker with its parent
Bag	G	Place a protective bag over the bunch
Bunch Prune	U	Remove one or more hands from a bunch
Choked	C	The bunch is trapped in the pseudo-stem
De-Bell	B	Remove the flower (bell) from the bunch
De-Sucker	D	Remove one or more suckers
Fallen	F	A banana tree has fallen to the ground
Flower	L	A flower has appeared on the tree
Height		Record the height of the tree
Hung	H	The bunch is hung in an adjacent tree
Info	I	Receive information about a row or tree
Nov. Dump	N	Fingers have non-uniform size
Pick	P	Pick the bunch from the tree
Ripe	R	The bananas are too ripe for harvest
Spit	S	The bunch has fallen to the ground
Trash	T	Remove dead leaves from the tree
Weight	W	Record a weight of the bunch

Table 1

[0052] The events listed in table 1 may be categorized into two or more groups. For instance, one group of events is related to an operator's passive observations. Such observed events include Choked, Fallen, Flower, Hung, Nov. Dump, Ripe, and Spit. With the exception of Flower, each of these observed events represents a type of banana production loss. Another group of events is related to active tasks performed by an operator. Such tasks include Bag, Bunch Prune, De-bell, De-sucker, Height, Pick, Trash, and Weight. Although Height and Weight could alternatively be considered passive observations, each arguably requires an active measurement step that goes beyond mere observation. The Info event is neither an observation nor a task. Instead, the Info event commands the processor 405 to display data related to the active row or active tree to the operator. Data that is responsive to the Info event may be displayed to the operator in the data portion 615 of the GUI 605.

[0053] Fig. 7 further illustrates a sub-menu 720 that can be displayed upon operator-selection of the Height event. By selecting a button within sub-menu 720 (through keypad navigation, use of hot keys 0-5, touch-screen activation, voice-activation, or otherwise), an operator can record the height of the active tree.

[0054] The structure and content of the menu features illustrated in Fig. 7 and described above could be varied according to design choice. For instance, in alternative embodiment of the invention, menu 715 could include an irrigation event. In alternative embodiments, the events listed in menu 715 might be abbreviated or referred to by other names. One or more events listed in menu 715 could also be omitted, and other events could be added, according to application needs. Moreover, an embodiment of the invention could allow a grower or operator to add one or more custom events.

[0055] Fig. 8 is a flow diagram of a tagging process, according to an embodiment of the invention. Fig. 8 is illustrated from the perspective of a banana grower or other human operator of the handheld device 305. As shown in Fig. 8, an operator begins the process in step 805, and plants a new patch in step 810. In conditional step 815, the operator determines whether the average tree height has exceeded a predetermined threshold. Conditional step 815 ensures that the pseudo-stem of newly-planted banana trees is sufficiently large to support a tag (e.g., barcode tag 500).

[0056] Once the condition of step 815 is satisfied, the operator logs onto the handheld device in step 820. The logon step 820 may be as simple as selecting the operator's name from a menu or other list. In an alternative embodiment, logon step 820 may require entry of a secure user ID and/or password. In yet another embodiment, logon step 820 could require the operator to scan a badge or other operator tag. The operator may then scan (or otherwise read data from) a row ID tag in step 825. Step 825 may include first tagging the row (for example attaching a row ID tag to a post or tree at one end of the row) if necessary. Next, in step 830, the operator may attach a tree ID tag to a first tree in the row, and the operator may scan the tree ID tag in step 835. In conditional step 840, the operator determines whether he/she is done tagging trees in the active row. Where the condition of step 840 is satisfied, the operator terminates the process in step 845. Where the condition of step 840 is not satisfied, the operator may return to step 830 to attach a tree ID tag to a next tree in the active row. The tagging process described with reference to Fig. 8 can also be applied to a sucker.

[0057] Variations to the flow illustrated in Fig. 8 are possible. For example, steps 810 and 815 are not required; an operator could tag trees and scan tree ID tags in a mature patch. One advantage of tagging trees in a new patch, however, is that there is not a canopy to potentially interfere with GPS signals (discussed below with reference to Fig. 9). Where trees are tagged using a stake in the soil near a tree (instead of tagging the tree itself), conditional step 815 could be eliminated. Additionally, as an alternative to step 825, an operator could scan the tree ID tag of another tree in the row (e.g., a tree ID tag for which a database record has already been created) to activate the row in the handheld device 305.

[0058] Fig. 9 is flow diagram of a tagging process, according to another embodiment of the invention. The tagging process illustrated in Fig. 9 is from the perspective of a data collection system. More specifically, Fig. 9 may represent functions of the application code 425 in the handheld device 305.

[0059] As illustrated in Fig. 9, the process begins in step 905 and then receives an operator logon in step 910. In step 915, the process may set the operator equal to an active operator. Step 915 may include displaying the active operator in the status portion 610 of the GUI 605. In step 920, the process receives a row ID (i.e., a row identification number). Then, in conditional step 925, the process determines whether a corresponding row ID record exists in memory (e.g., in database 430). Where the condition of step 925 is not met, the process advances to step 930 to create the row ID record in the memory. The process then sets the row ID number equal to the active row in step 935. Step 935 may include displaying the active row ID in the status portion 610 of the GUI 605. Where the result of conditional step 925 was satisfied, the process also advances to step 935.

[0060] Subsequent to step 935, the process may receive a tree ID (e.g., a tree identification number) in step 940. Next, in conditional step 945, the process determines whether a corresponding tree ID record exists in the memory (e.g., database

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430). Where the result of conditional step 945 is not satisfied, the process advances to step 950 to create a tree ID record in the memory. The tree ID record created in step 950 preferably includes a reference to the active row ID. The process then sets the tree ID equal to the active tree in step 955. Step 955 may include displaying the active tree ID in the status portion 610 of the GUI 605. Where the result of conditional step 945 is satisfied, the process also advances to step 955.

[0061] Subsequent to step 955, the process determines whether position data exists for the active tree in conditional step 960. This can be determined by reading the tree ID record for the active tree. Where the result of conditional step 960 is not satisfied, the process attempts to acquire GPS position data (e.g., via GPS receiver 460) in step 965. Next, in conditional step 970, the process determines whether GPS data was successfully acquired. Where the condition of step 970 is satisfied, the process adds the newly-acquired position data to the tree ID record in step 975, and then terminates in step 980. Step 975 may include displaying the newly-acquired position data in the status portion 610 of the GUI 605. Where conditional step 960 is satisfied (indicating that position data already exists), and where conditional step 970 is not satisfied (indicating that GPS data could not be retrieved), the process may terminate in step 980.

[0062] The process illustrated in Fig. 9 thus builds tree ID records in response to row ID and tree ID inputs. Advantageously, the GPS position data may be collected absent operator intervention. The tagging process described with reference to FIG. 9 is equally applicable to a sucker.

[0063] Variations to the process illustrated in Fig. 9 are possible. In an alternative embodiment, steps 920, 925, and 930 may be replaced by first receiving an existing tree ID, and then determining the row ID from a tree ID record that is associated with the existing tree ID. In addition, the process illustrated in Fig. 9 could be changed by eliminating conditional step 960. In this instance, a newly-acquired position could be compared to a previously-acquired position, and a warning could be output to the operator if the difference between the two values exceeds a predetermined threshold. In an alternative embodiment steps 965 and 970 could be replaced by receiving manual entry of the position data from an operator.

[0064] After an operator has performed the tagging process, he/she may record events against any tagged row or tree. The tagging process may be as described above with reference to Figs. 8 and 9. The events may be as listed in Table 1. In an embodiment of the invention, recording an event generally requires the operator to first select the event, and then scan the tag. For example, an operator may select the Flower event on the handheld device (for instance by navigating the menu 715 or by entering the shortcut key "F"), and then scan a tree tag. In this instance, the application code (e.g., the application code 425) would: receive the selection of the Flower event; set the Flower event = the active event; receive the tree ID; and append the corresponding tree ID record with a date and Flower event code. If the operator next observes a flower on a second tree, the operator could simply scan the second tree tag without having to re-select the Flower event. In response, the application code would receive the second tree ID and append the second tree ID record with the date and Flower event code.

[0065] In an alternative embodiment, the sequence for recording events could be changed so that the operator first scans a tree tag, and then selects the event. One or more additional events could be recorded against the same tree without re-scanning the tree tag. For instance, the operator could first scan a tree tag, and then select events F and T. In this case, the application code would: receive the tree ID; receive the selection of the Flower event; append the corresponding tree ID record with the current date and Flower event code; receive the selection of the Trash event; and append the corresponding tree ID record with the current date and Trash event code.

[0066] The Adopt event is different than the general case described in the two preceding paragraphs because the Adopt event involves both a sucker and a parent tree. In an embodiment described below with reference to Fig. 10, an operator scans a sucker tag, selects the Adopt event, and then scans a parent tree tag. In an alternative embodiment, the sequence could be changed so that the operator first scans the parent tree tag, selects the Adopt event, and then scans the sucker tag.

[0067] Fig. 10 is a flow diagram of an adoption process, according to an embodiment of the invention. Fig. 10 is from the perspective of an operator. As shown therein, the process begins in step 1005. Next, an operator may logon in step 1010 and scan a row tag (e.g., a barcode tag 500) in step 1015. Next, in step 1020, an operator may attach a tag (e.g., a barcode tag 500) to a sucker in the row. The operator scans the sucker tag in step 1025 and selects an “adopt” command from an event menu in step 1030. The operator then scans a parent tree tag (e.g., a barcode tag 500) in step 1035 before terminating the process in step 1040.

[0068] Fig. 11 is a flow diagram of an adoption process, according to an embodiment of the invention. Fig. 11 is illustrated from the perspective of a data collection system. More specifically, Fig. 11 may represent functions of the application code 425 in the handheld device 305.

[0069] As shown in Fig. 11, the process begins in step 1105 with a sucker ID as the active tree. This would be the case, for instance, after receiving a sucker ID (sucker identification number) and after having created a sucker ID record in memory (e.g. database 430). In step 1110, the process receives an adoption command.

[0070] Next, in conditional step 1115, the process determines whether the current date is a valid date for adoption. In determining whether the condition in step 1115 is satisfied, the process may consult a predetermined list of invalid adoption dates. The predetermined list of invalid adoption dates might be compiled, for instance, based on an assessment of historical data, patch-wide, that is associated with non-uniform finger sizes, choking, or other defects. Where the condition in step 1115 has not been met (in other words, where the current date is not valid), the process may display a warning message in step 1120. Then, based on operator response to the warning message, the process may determine in conditional step 1123 whether to abort. Where the process is not being aborted, the process advances to step 1125. Where the condition of step 1115 is met, the process also advances to step 1125 to receive a parent tree ID.

[0071] Subsequent to step 1125, the process advances to conditional step 1130 to determine whether a parent tree ID record exists in memory for the received parent tree ID. Where the result of the condition in step 1130 is not satisfied, the process creates a parent tree ID record in memory (e.g., in database 430) in step 1145. Then, in step 1150, the process supplements the sucker ID record with a reference to the parent tree ID.

[0072] If the condition in step 1130 is satisfied, the process advances to conditional step 1135 to determine whether the parent tree should adopt. A sucker will drain resources from a parent tree. Accordingly, conditional step 1135 may include determining whether the parent tree has reached an adequate stage of maturity to support the adoption of a sucker. In this instance, the process could simply read age or height data from the parent tree ID record for comparison to a predetermined age or height threshold. Alternatively, or in combination, conditional step 1135 could include determining whether the parent tree has already adopted a sucker.

[0073] Where the result of conditional step 1135 is not satisfied (this is, it is determined that the parent tree should not adopt), the process displays a warning message in step 1140. Then, based on operator response to the warning message, the process may determine in conditional step 1143 whether to abort. Where the process is not being aborted, the process advances to step 1150. Where the condition in step 1135 was satisfied, the process also advances to step 1150.

[0074] Subsequent to step 1150, the process advances to conditional step 1155 to determine whether position data exists in the parent tree ID record. Where the condition of step 1155 is met (that is, where position data does exist for the parent tree), the process advances to conditional step 1165 to determine whether position data exists in the sucker ID record. Where the condition in step 1165 is not satisfied (that is, where position data does not exist for the sucker), the process copies position data from the parent tree ID record to the sucker ID record in step 1180, and then the process terminates in step 1185.

[0075] Where the condition in step 1155 is not satisfied, the process attempts to acquire GPS position data (e.g., via GPS receiver 460) in step 1160. Then, in conditional step 1175, the process determines whether the GPS data acquisition was successful. Where the condition in step 1175 was not satisfied, the process terminates in step 1185; otherwise, the process advances to step 1170 to write the acquired position data into the parent tree ID record. Then, the process advances to conditional step 1165. If conditional step 1165 is satisfied, the process terminates in step 1185.

[0076] Accordingly, the process illustrated in Fig. 11 associates a sucker with its parent tree. Additionally, position data associated with the parent tree ID may be automatically copied to the sucker ID record.

[0077] The process flow illustrated in Fig. 11 may be varied, according to design choice. For example, in one embodiment, step 1120 displays an error message (instead of a warning) and conditional step 1123 is omitted so that when the condition in step 1115 is not satisfied, the process displays the error message and terminates in step 1185. Such an embodiment prevents an operator from performing an adoption when historical data for the patch predicts low yield for any new sucker at the current date.

[0078] Alternatively, or in combination with any other embodiment, step 1140 displays an error message (instead of a warning) and conditional step 1143 is omitted. In this instance, when the condition of step 1135 is not satisfied, the process displays the error message and terminates in step 1185. Such an embodiment prevents an operator from performing an adoption when the parent tree has not reached an adequate stage of maturity for adoption and/or when the parent tree has already adopted a sucker.

[0079] In the alternative to, or in combination with, step 1145, the process could supplement the parent tree ID record with a reference to the sucker ID.

[0080] In yet another alternative embodiment, any time an operator scans a new tree tag, the application code 425 could default to a Tag event to create the new tree ID record. In this instance, the Adopt event would be aborted. In other words, Adopt events could only be completed where a tree ID has already been created in memory.

[0081] Additional logic that is not illustrated in Figs. 8 -11 could be used as events are recorded in a banana patch. To facilitate such logic, each event could include metadata that allows the application code 425 to perform some level of transactional validation. For instance, certain events (such as the Flower event) could be identified as one-time events. Accordingly, the application code 425 could prevent such one-time events from being recorded multiple times for a single tree. Likewise, some events (e.g., a Spit event) could be coded as a terminal event so that the application code 425 would not permit any further events to be recorded for a tree after recording one such terminal event for the tree. The application code 425 could also support bulk event transactions that would prompt the operator to record an event at the row or patch level. The Trash event is an example of an event that might be performed and recorded in bulk. Moreover, the logic of the application code 425 could implement workflow principles such that events can only be recorded according to a predetermined sequence. For example, the application code 425 could require that a De-Bell Event precede a Bunch Prune Event. In an automatic variant of the workflow feature, the application code 425 could automatically record a next event in the predetermined sequence each time a tree is scanned. In this instance, the application code 425 could prompt an operator to choose from a list of possibilities if there is a choice of next events in the predetermined sequence.

[0082] Fig. 12 is a flow diagram of an information display process, according to an embodiment of the invention. The process in Fig. 12 is from the prospective of an operator using a handheld device (e.g., the handheld device 305). The process begins in step 1205 and the operator logs on in step 1210. Next, the operator may select "info" from the event menu (e.g., the menu 715) in step 1215. Then, the operator may scan a row tag in step 1220 and view row information on a handheld device (e.g., in the data portion 615 of the GUI 605) in step 1225 before terminating in step 1230. Accordingly, an operator may receive data from the handheld device as well as input data into the handheld device.

[0083] Variations to the process illustrated in Fig. 12 are possible. For instance, in an alternative embodiment, the sequence of operations is altered so that step 1215 is performed after step 1220 and before step 1225. In an alternative embodiment, the operator could scan a tree tag in step 1220 and view tree information in step 1225. The tree information may be or include, for example, a history of events associated with the active tree.

[0084] Fig. 13 is a flow diagram of an information display process, according to an embodiment of the invention. The process illustrated in Fig. 13 is from the perspective of a data collection system. More specifically, the process in Fig. 13 may describe operation of the application code 425 in the handheld device 305.

[0085] The process in Fig. 13 may begin in step 1305. Next, the process may receive an operator logon in step 1310 and set the operator equal to an active operator in step 1315. Step 1315 may include displaying the active operator in the status portion 610 of the GUI 605. Next, the process may receive an "information" command in step 1320 and may further receive a row ID in step 1325. Next, in step 1330, the process sets the row ID equal to the active row. Step 1330 may include displaying the active

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row ID in the status portion 610 or the GUI 605. In step 1335, the process displays row information for the active row (e.g., in the data portion 615 of the GUI 605) before the process terminates in step 1340. Accordingly, a handheld device may be configured to display information to an operator.

[0086] Variations to the process illustrated in Fig. 13 are possible. For instance, in an alternative embodiment, the sequence of operations is altered so that step 1320 is performed after step 1330 and before step 1335. Moreover, in an alternative embodiment, the process receives a tree ID in step 1325, sets the tree ID = active tree in step 1330, and displays tree info associated with the active tree in step 1335. The tree information may be or include, for example, a history of events associated with the active tree.

[0087] Fig. 14 is an illustration of a graphical user interface, according to an embodiment of the invention. The graphical user interface 605 illustrated in Fig. 14 may represent the result of an information command. As shown therein, the status window 610 illustrates that the handheld device is displaying the information event and has received a logon from operator J. Smith. Fig. 14 further illustrates that operator J. Smith has scanned row 99. In the data portion 615 of the graphical user interface 605, the operator may receive information representing the age bunches in row 099. The age may represent, for example, the number of days since the bunch was de-belled. The data portion 615 may include a slider bar 1405 to enable scrolling through data that is displayed in the data portion 615.

[0088] In an alternative embodiment of the invention, or in combination with the processes illustrated in Figs. 12 and 13, the application code 425 could display row information (e.g., the age information illustrated in Fig. 14) to an operator in response to an operator's scan of a row tag, even absent the selection of an Info event.

[0089] Fig. 15 is a functional block diagram of a defect-skipping application, according to an embodiment of the invention. As illustrated in Fig. 15, a defect-skipping application 1505 receives historical defect data for a patch 1510 as input. The historical defect data may be a sub-set of historical event data. For instance the historical defect data may be data related to recorded Choked, Fallen, Flower, Hung, Nov. Dump, Ripe, and/or Spit events. The defect-skipping application 1505 outputs a de-suckering schedule 1515 and/or an adoption warning date range 1520. By scheduling patch-wide de-suckering, for example, and/or by specifying an adoption warning date range, a grower may skip likely defects. Skipping defects may improve the efficiency of plantation resources (especially labor), and may improve overall banana production in a patch.

[0090] Fig. 16 is flow diagram of a defect-skipping process, according to an embodiment of the invention. The process in Fig. 16 is an exemplary embodiment of the defect-skipping application 1505.

[0091] As illustrated in Fig. 16, the process starts in step 1605, and receives historical defect data associated with at least one patch in step 1610. Preferably, step 1610 is based on data received from multiple handheld devices in a patch. In embodiments of the invention, step 1610 includes receiving data from multiple regional patches. Next, in step 1615, the process determines at least one statistically-significant time period based on the historical defect data. For example, it may be determined that there is a statistically high incidence of choking during the month November. Next, in step 1620, the process determines an average time-to-defect based on the historical defect data. A single time-to-defect may be expressed, for example, by comparing the date of a recorded defect with the date of that same tree's adoption. Multiple single time-to-defect values can then be averaged to determine the average time-to-defect. In step 1625, the process outputs a de-suckering schedule based on the at least one statistically-significant time period and the average time-to-defect. Alternatively, or in combination, the process may output an adoption warning date range in step 1630 that is also based on the at least one statistically-significant time period and the average time-to-defect. Step 1635 could include transferring the adoption warning date range to one or more handheld devices. In the handheld deices, the adoption warning date range could be used to either warn against, or prevent, adoptions, as described above with reference to Fig. 11.

[0092] Fig. 17 is a functional block diagram of a bunch harvest forecasting application, according to an embodiment of the invention. As shown in Fig. 17, a bunch harvest forecast application 1705 receives historical event data for a patch 1710 and outputs a near-term bunch harvest forecast 1715. A near-term bunch harvest forecast

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1715 may allow a grower to optimize banana prices with distributors and/or retailers.

[0093] Fig. 18 is a flow diagram of a bunch harvest forecasting process, according to an embodiment of the invention. The process in Fig. 18 is an exemplary embodiment of the bunch harvest forecasting application 1705. As illustrated in Fig. 18, the process begins in step 1805 and receives historical event data for a patch in step 1810. Next, in step 1815, the process calculates an average time-to-maturity based on the event data. In one embodiment, a single time-to-maturity value may be based on the difference between a de-bell date and a pick date; the average time-to-maturity can be calculated from multiple single time-to-maturity values. Then, in step 1820, the process calculates an average monthly yield based on the historical event data. The average monthly yield may be based, for example, on recorded Fallen, Hung, Nov. dump, Ripe, and Spit events in the event data. Finally, in step 1825, the process outputs a near-term bunch harvest forecast based on the average time-to-maturity, average monthly yield, and the current status of trees and suckers in the patch.

[0094] Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", 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.

[0095] The reference to any prior art in this specification is not, and should not be taken as, an acknowledgement or any form of suggestion that the prior art forms part of the common general knowledge in Australia.

[0096] It will be apparent to those skilled in the art that modifications and variations can be made without deviating from the spirit or scope of the invention. For example, alternative features described herein could be combined in ways not explicitly illustrated or disclosed. Thus, it is intended that the present invention cover any such modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

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The claims defining the invention are as follows:

1. A method for collecting data in a banana patch, the method comprising the steps of:

affixing an identification tag to a banana tree in said banana patch, wherein said identification tag is indicative of a tree identification record;

assigning said tree identification record to said banana tree in a memory;

recording one of a plurality events against said tree identification record to develop historical event data for said banana patch;

analysing said historical event data to provide a bunch harvest forecast, wherein said historical event data includes historical defect data for said banana patch,

wherein said tag comprises:

a pointed-end adapted for insertion into a pseudo-stem of said banana tree, such that when said tag is inserted into the pseudo-stem, it is not displaced even when the hole in said pseudo-stem created by insertion of said tag dries out;

a machine-readable portion disposed on said tag; and

a human-readable portion disposed on said tag;

wherein said machine-readable and human-readable portions are disposed on said tag such that said portions are substantially weather-proof,

wherein said tag affixed to said banana tree is read using a hand-held device, said hand-held device comprising:

a tag reader for reading the machine-readable portion of said tag;

a positioning module for determining positioning data of said tag; and

a processor for appending said positioning data to said tree identification record of said tree,

wherein said hand-held device further comprises:

a memory for storing said historical event data;

an input module for receiving operator input; and

an output module for outputting said de-suckering schedule and said bunch harvest forecast.

2. A method according to claim 1 wherein said historical defect data is analysed

to provide a de-suckering schedule to reduce likely defects, thereby improving banana production in said banana patch.

3. A method according to claim 2 wherein said bunch harvest forecast is revised based on said de-suckering schedule thereby to provide a revised bunch harvest forecast.

4. A method according to claim 1, the method further comprising:

affixing an identification tag to a sucker of said banana tree, wherein said identification tag is indicative of a sucker identification record;

assigning said sucker identification record to said sucker in a memory; and

supplementing said sucker identification record with said tree identification record.

5. A method according to claim 4 wherein, in response to an Adopt event, said position data is copied from said tree identification record and appended to said sucker identification record.

6. A method according to claim 2 or claim 3 wherein said de-suckering schedule is calculated based on:

determining at least one statistically-significant time period of high defects based on historical defect data; and

determining an average time-to-defect based on historical defect data.

7. A method according to any one of the preceding claims wherein said bunch harvest forecast is determined based on:

calculating the average time to maturity based on historical event data for said banana patch

calculating the average monthly yield based on historical event data for said banana patch; and

the observed current status of trees and suckers in said banana patch.

8. A method according to any one of the preceding claims, wherein said plurality of events includes one or more of: Adopt, Bag, Bunch Prune, Choked, De-Bell, De-

Sucker, Fallen, Flower, Height, Hung, Info, Nov. Dump, Pick, Ripe, Spit, Trash and Weight.

9. A system for collecting data in a banana patch, the system comprising:

an identification tag that is affixed to a banana tree in said banana patch, wherein said identification tag is indicative of a tree identification record;

a memory for storing said tree identification record assigned to said banana tree;

a database for recording one of a plurality events against said tree identification record to develop historical event data for banana trees in said banana patch; and

a processor configured to analyse said historical event data to provide a first bunch harvest forecast, wherein said historical event data includes historical defect data for said banana patch,

wherein said tag affixed to said banana tree is read using a hand-held device, said hand-held device comprising:

a tag reader for reading the machine-readable portion of said tag;

a positioning module for determining positioning data of said tag; and

a processor for appending said positioning data to said tree identification record of said tree,

wherein said hand-held device further comprises:

a memory for storing said historical event data;

an input module for receiving operator input; and

an output module for outputting said de-suckering schedule and said bunch harvest forecast.

10. A system according to claim 9 wherein said historical defect data is analysed to provide a de-suckering schedule to reduce likely defects, thereby improving banana production in said banana patch.

11. A system according to claim 10 wherein said bunch harvest forecast is revised based on de-suckering schedule thereby to provide a revised bunch harvest forecast.

12. A system according to claim 9, wherein said tag comprises:

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a pointed-end adapted for insertion into a pseudo-stem of said banana tree, such that when said tag is inserted into the pseudo-stem, it is not displaced even when the hole in said pseudo-stem created by insertion of said tag dries out;

a machine-readable portion disposed on said tag; and

a human-readable portion disposed on said tag;

wherein said machine-readable and human-readable portions are disposed on said tag such that said portions are weather-proof.

13. A system according to claim 9, wherein said system further comprises a host computer coupled to said hand-held device.

14. The system according to claim 13, wherein the system further comprises an irrigation controller coupled to said host computer, said irrigation controller configured to output irrigation data to said host computer, wherein said irrigation data is merged with data received from said hand-held device.

15. The system according to claim 13 or claim 14, wherein the system further comprises an environmental sensor coupled to said host computer, said environmental sensor configured to output environmental data to said host computer, wherein said environmental data is merged with data received from said hand-held device, said environmental data including at least one of temperature, wind speed, and rainfall data.

16. A method for collecting data in a banana patch substantially as herein described.

17. A system for collecting data in a banana patch substantially as herein described.

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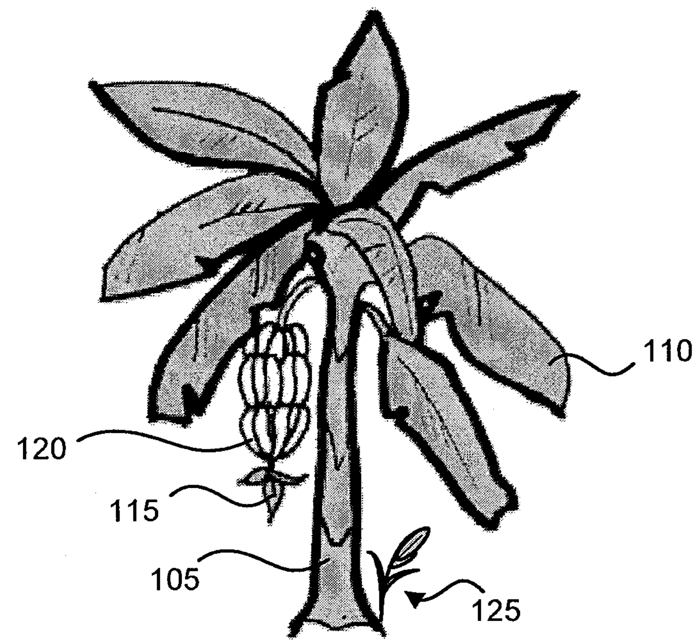

FIG. 1

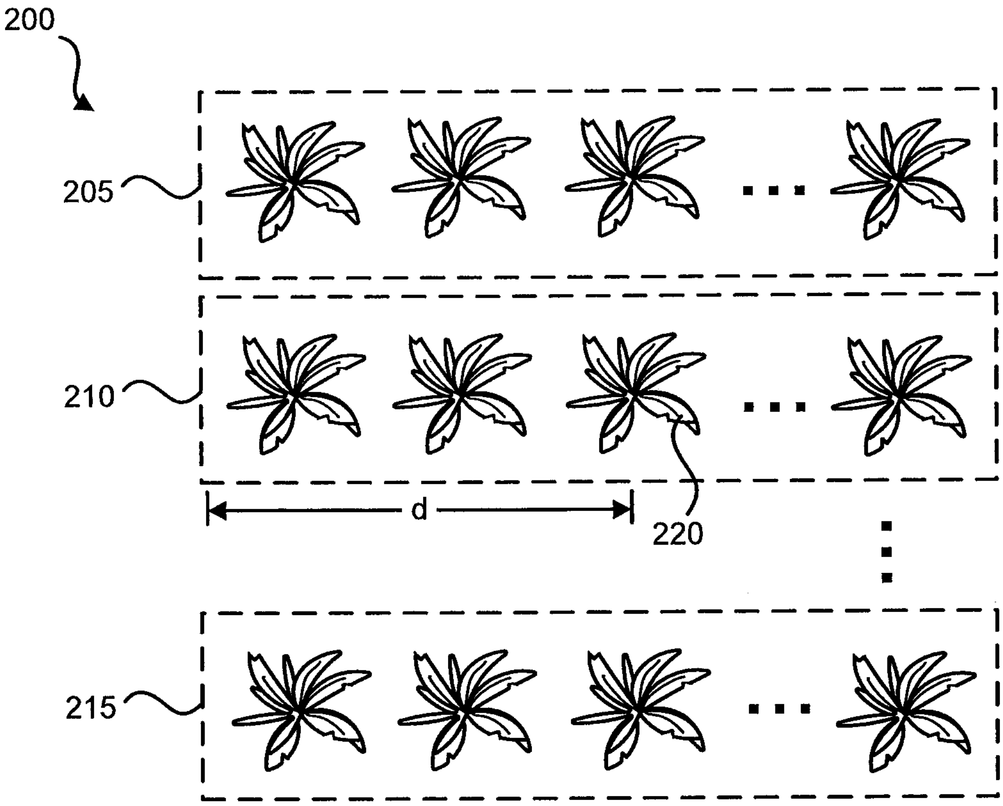

FIG. 2

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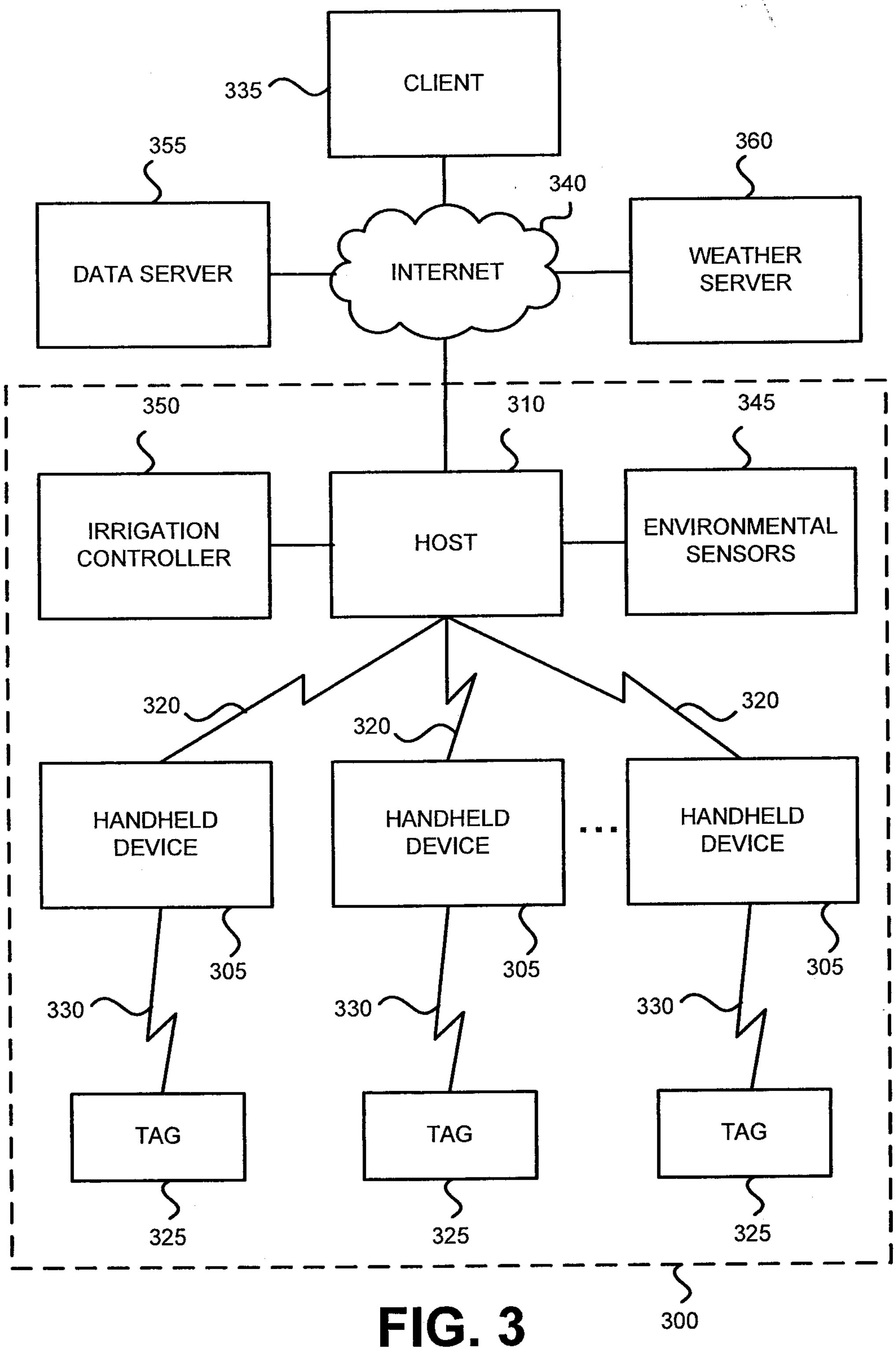

FIG. 3

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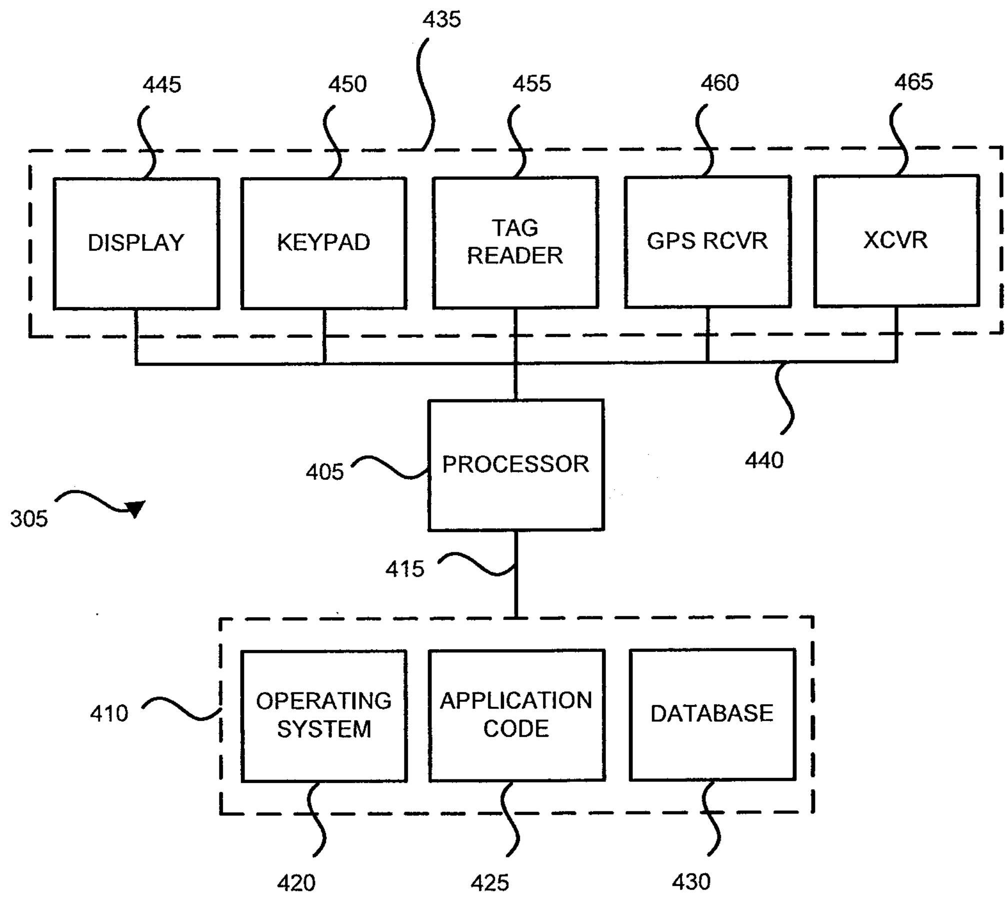

FIG. 4

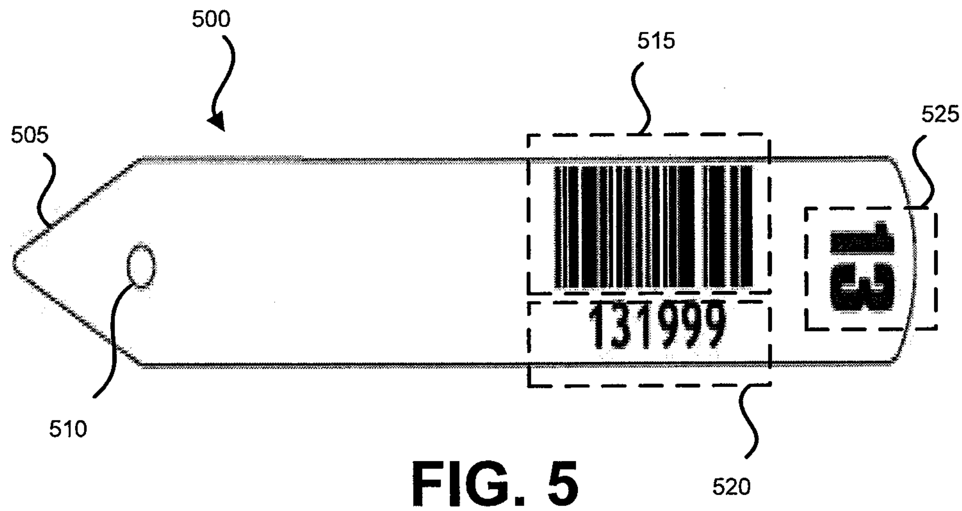

FIG. 5

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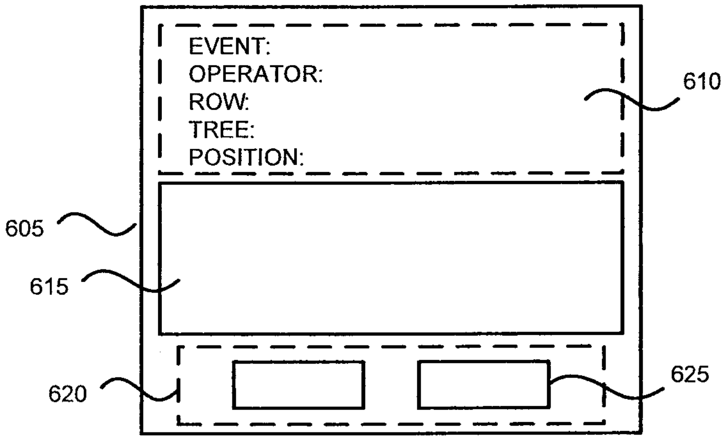

FIG. 6

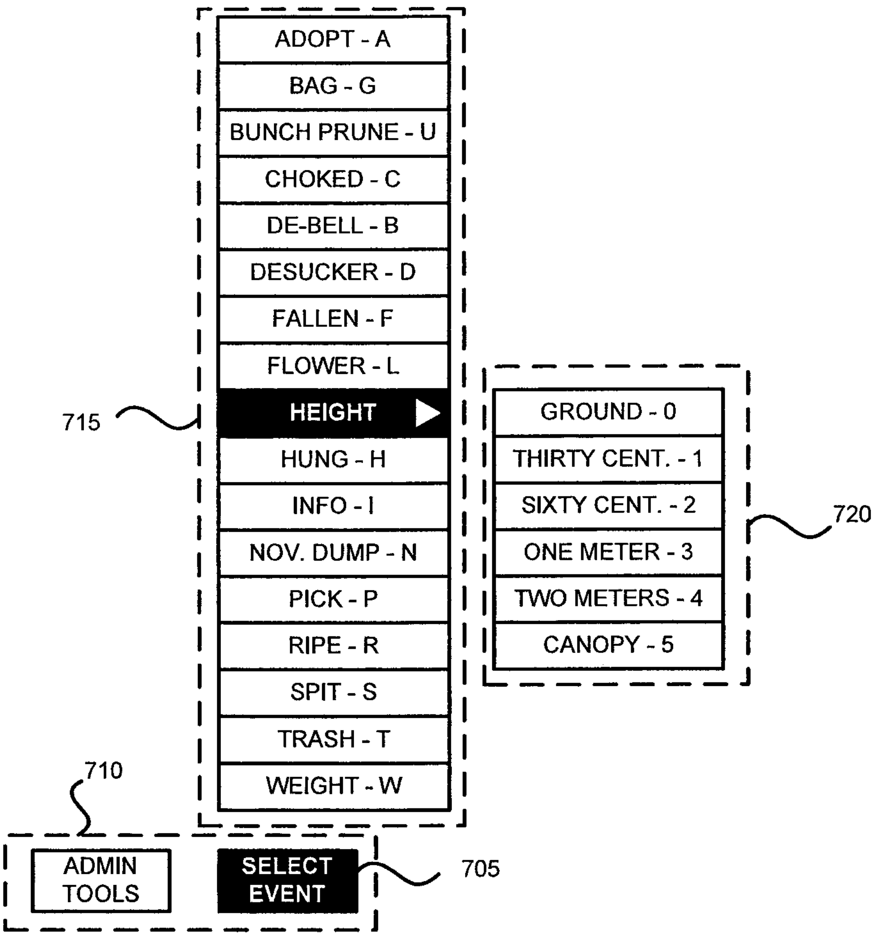

FIG. 7

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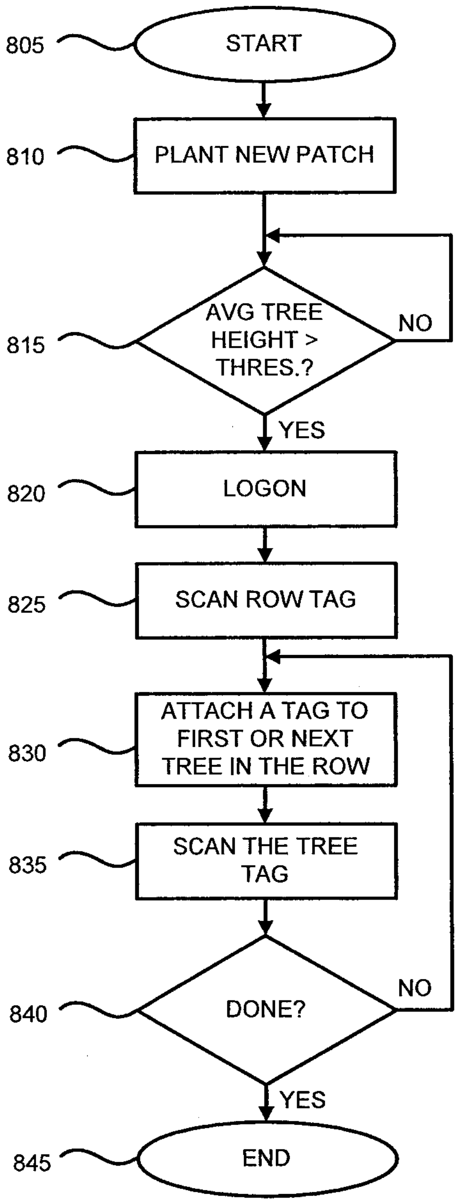

FIG. 8

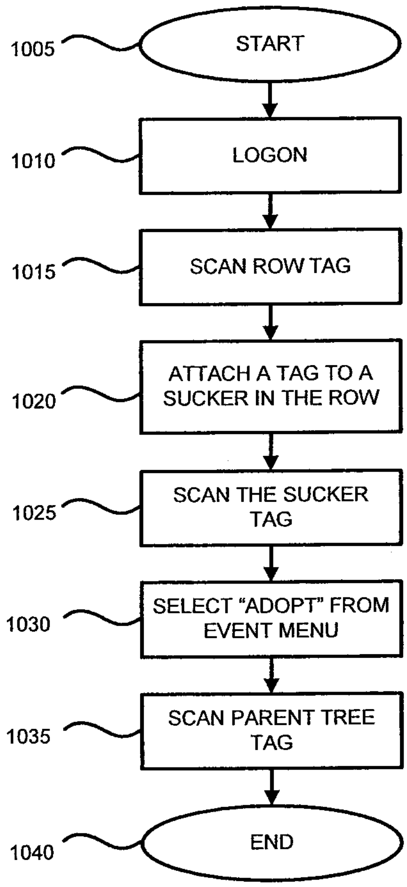

FIG. 10

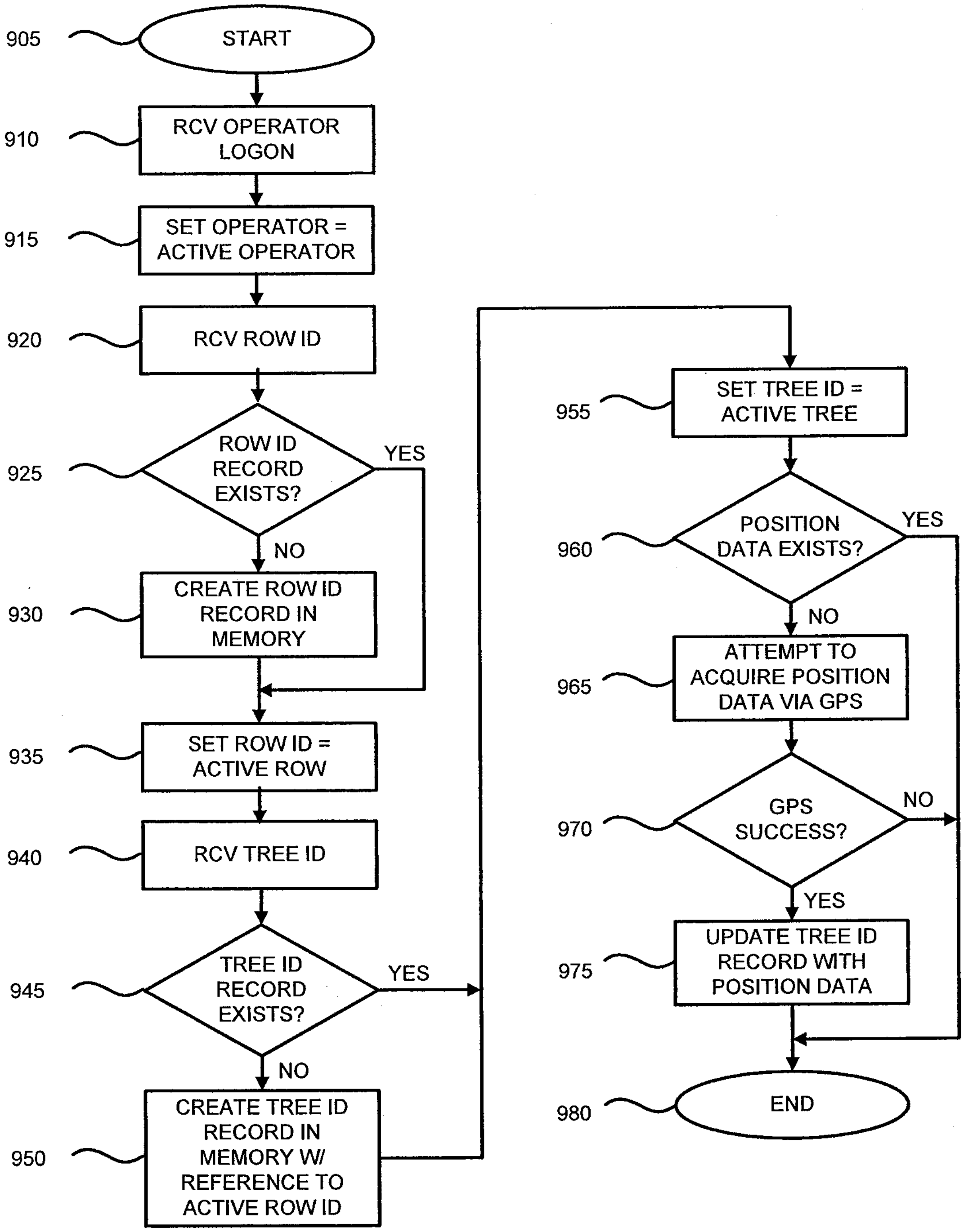
905
START
910
RCV OPERATOR LOGON
915
SET OPERATOR = ACTIVE OPERATOR
920
RCV ROW ID
925
ROW ID RECORD EXISTS?
YES
NO
930
CREATE ROW ID RECORD IN MEMORY
935
SET ROW ID = ACTIVE ROW
940
RCV TREE ID
945
TREE ID RECORD EXISTS?
YES
NO
950
CREATE TREE ID RECORD IN MEMORY W/ REFERENCE TO ACTIVE ROW ID
955
SET TREE ID = ACTIVE TREE
960
POSITION DATA EXISTS?
YES
NO
965
ATTEMPT TO ACQUIRE POSITION DATA VIA GPS
970
GPS SUCCESS?
NO
YES
975
UPDATE TREE ID RECORD WITH POSITION DATA
980
END

FIG. 9

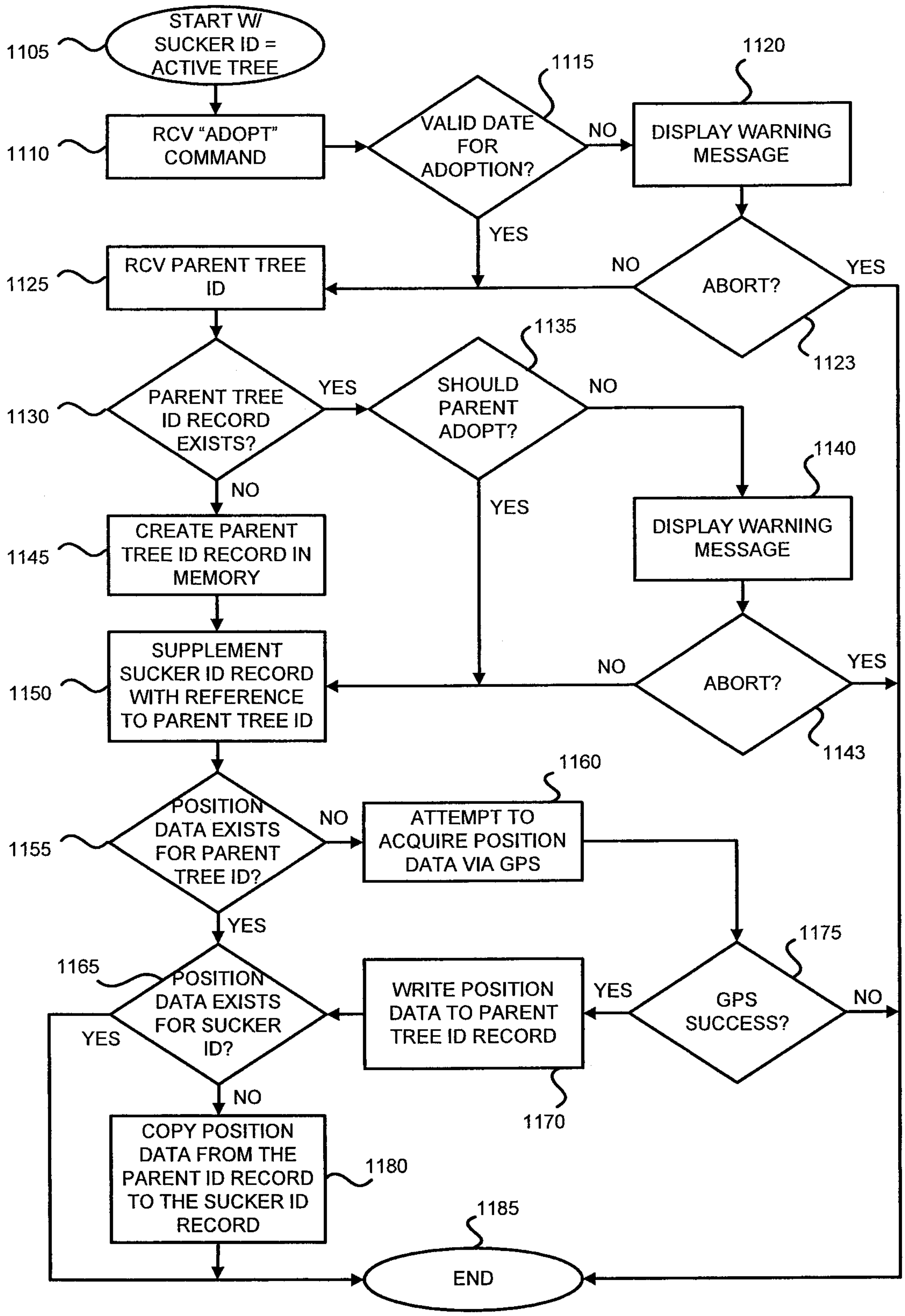
START W/ SUCKER ID = ACTIVE TREE
1105
RCV "ADOPT" COMMAND
1110
VALID DATE FOR ADOPTION?
1115
NO
DISPLAY WARNING MESSAGE
1120
YES
RCV PARENT TREE ID
1125
NO
ABORT?
YES
1123
PARENT TREE ID RECORD EXISTS?
1130
YES
SHOULD PARENT ADOPT?
1135
NO
1140
NO
CREATE PARENT TREE ID RECORD IN MEMORY
1145
YES
DISPLAY WARNING MESSAGE
SUPPLEMENT SUCKER ID RECORD WITH REFERENCE TO PARENT TREE ID
1150
NO
ABORT?
YES
1143
POSITION DATA EXISTS FOR PARENT TREE ID?
1155
NO
ATTEMPT TO ACQUIRE POSITION DATA VIA GPS
1160
YES
1165
POSITION DATA EXISTS FOR SUCKER ID?
YES
WRITE POSITION DATA TO PARENT TREE ID RECORD
YES
GPS SUCCESS?
1175
NO
1170
NO
COPY POSITION DATA FROM THE PARENT ID RECORD TO THE SUCKER ID RECORD
1180
1185
END

FIG. 11

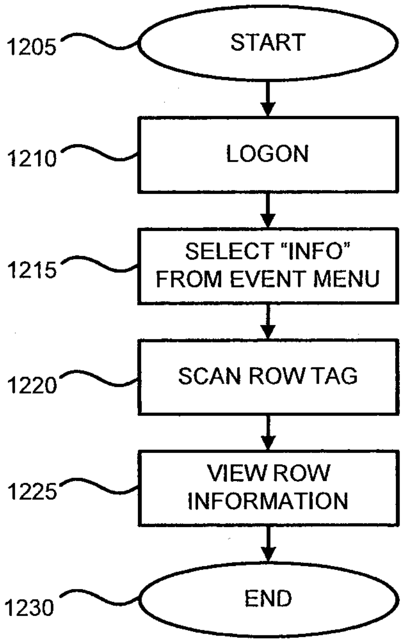

FIG. 12

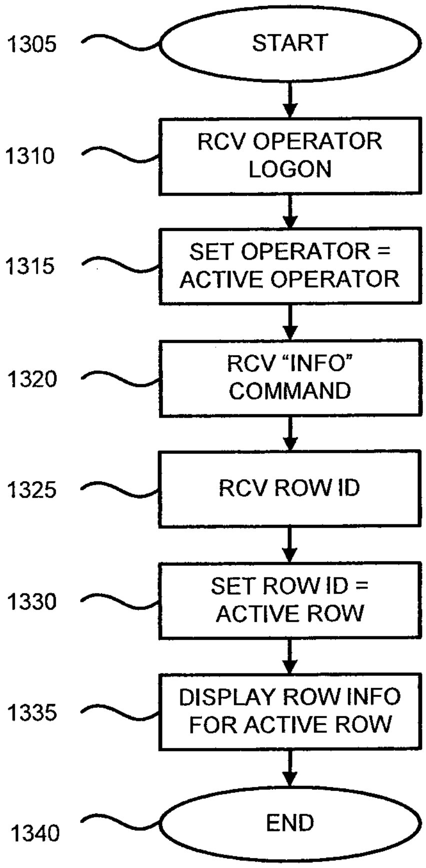

FIG. 13

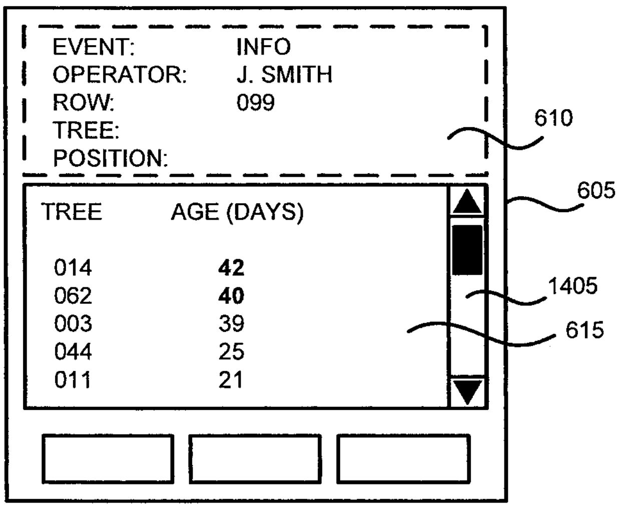

FIG. 14

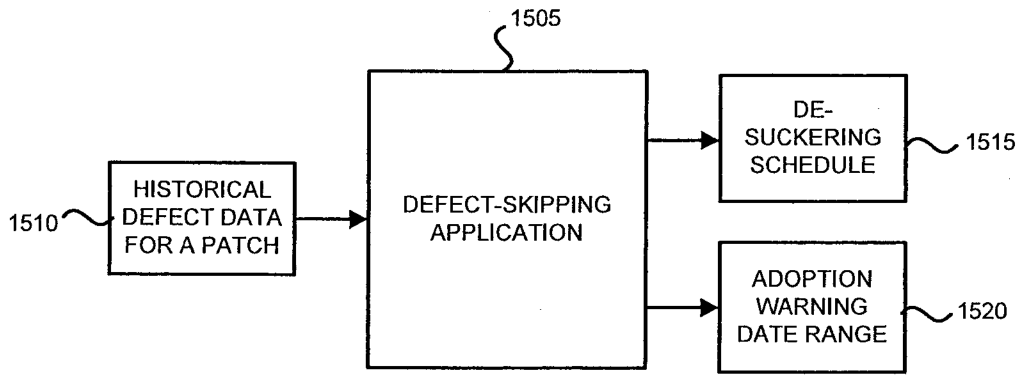
1505
1510
HISTORICAL DEFECT DATA FOR A PATCH
DEFECT-SKIPPING APPLICATION
DE-SUCKERING SCHEDULE
1515
ADOPTION WARNING DATE RANGE
1520

FIG. 15

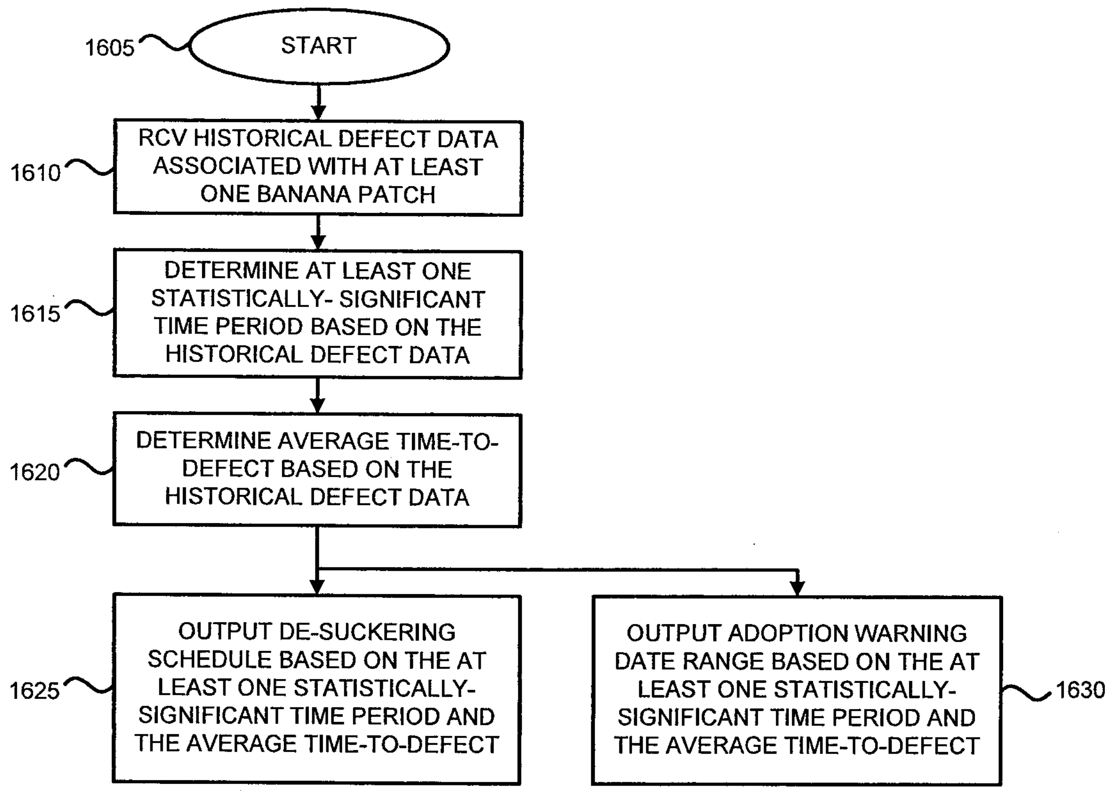
1605
START
1610
RCV HISTORICAL DEFECT DATA ASSOCIATED WITH AT LEAST ONE BANANA PATCH
1615
DETERMINE AT LEAST ONE STATISTICALLY- SIGNIFICANT TIME PERIOD BASED ON THE HISTORICAL DEFECT DATA
1620
DETERMINE AVERAGE TIME-TO-DEFECT BASED ON THE HISTORICAL DEFECT DATA
1625
OUTPUT DE-SUCKERING SCHEDULE BASED ON THE AT LEAST ONE STATISTICALLY-SIGNIFICANT TIME PERIOD AND THE AVERAGE TIME-TO-DEFECT
OUTPUT ADOPTION WARNING DATE RANGE BASED ON THE AT LEAST ONE STATISTICALLY-SIGNIFICANT TIME PERIOD AND THE AVERAGE TIME-TO-DEFECT
1630

FIG. 16

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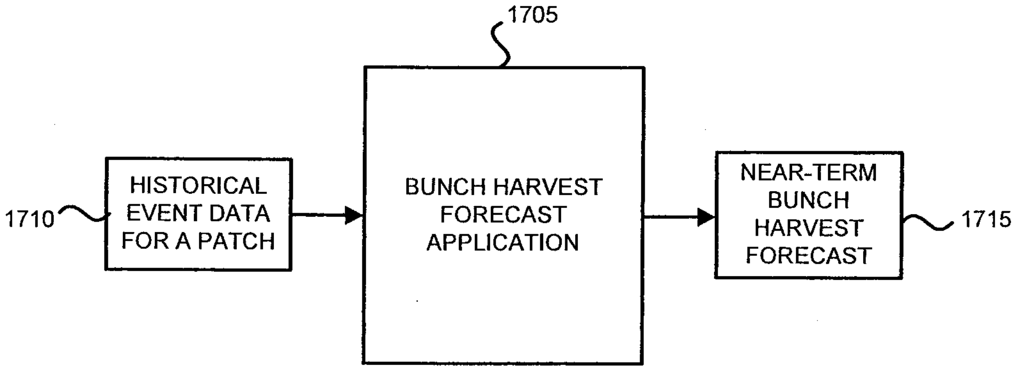

FIG. 17

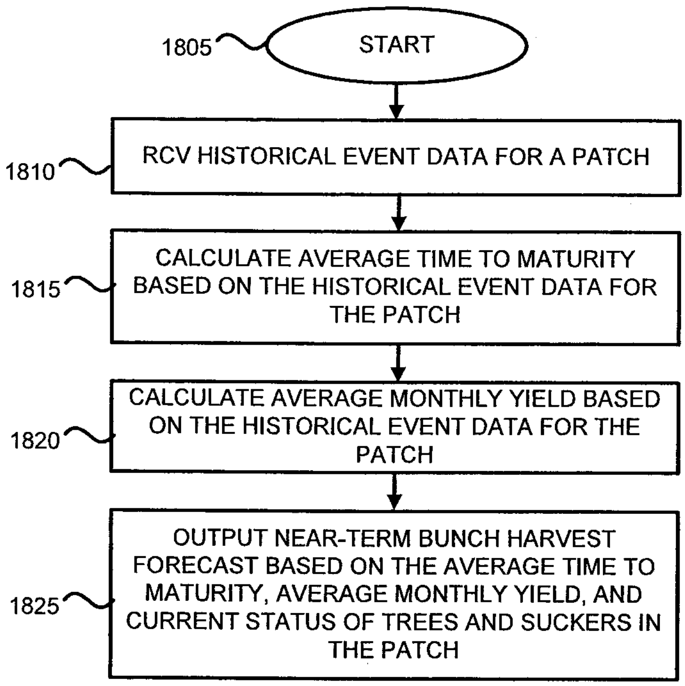

FIG. 18