(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 March 2004 (04.03.2004)

PCT

(10) International Publication Number
WO 2004/019265 A1

(51) International Patent Classification[7]: G06K 15/00

(21) International Application Number:
PCT/US2003/009020

(22) International Filing Date: 24 March 2003 (24.03.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/226,475 23 August 2002 (23.08.2002) US
10/304,671 25 November 2002 (25.11.2002) US

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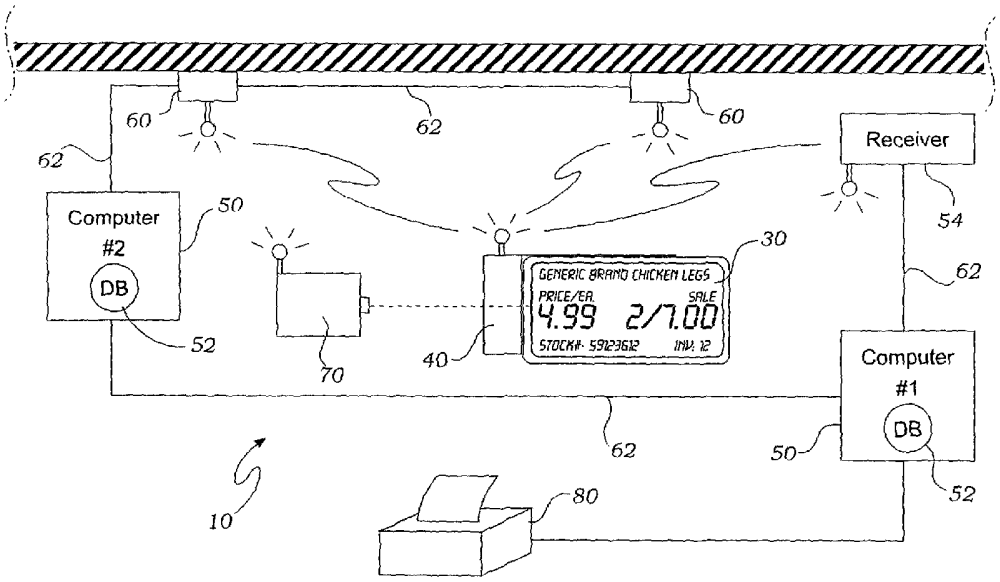
(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report
— with amended claims and statement

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: INVENTORY CONTROL AND IDENTIFICATION APPARATUS AND METHOD



(57) Abstract: Identification labels (30) are positioned in physical correspondence with inventory items (20) in a storage space (10). Each label has a display face (32), a mounting device (34) for fixing them to shelves, walls, etc. adjacent to certain of the inventory items (20) and a transceiver (40). A graphical or text presentation (38) appears on the display face (32) of the label (30) to identify the inventory items (20). A network of further transceivers (60) is mounted within the storage space (10). The transceivers (40) and (60) are in wireless communication with each other. Using ultra-wide-band radio technique, the labels (30) are in communication with a computer system (50) through the network (60). A portable proximity reader (70) is able to communicate with the labels (30) to access and input information therewith. A triangulation technique is used to locate each of the labels (30) in 3-space so that location and identity of storage items (20) is known.

WO 2004/019265 A1

TITLE: Inventory Control Identification Apparatus and Method

BACKGROUND OF THE INVENTION

INCORPORATION BY REFERENCE: Applicant(s) hereby incorporate herein by reference, any and all U. S. patents, U.S. patent applications, and other documents and printed matter cited or referred to in this application.

FIELD OF THE INVENTION:

This invention relates generally to inventory systems and more particularly to such a system capable of locating items of inventory in a three-space environment.

DESCRIPTION OF RELATED ART:

The following art defines the present state of this field:

Goodwin, III, U.S. 5,794,215 describes a method of optimizing electronic price label (EPL) systems which employs a three-dimensional graph of retry levels in a transaction establishment. The method includes the steps of determining locations of EPLs within the transaction establishment, determining locations of transmit and receive antennas that are used by a computer to communicate with the EPLs, determining retry levels for the EPLs, mapping the retry levels to locations within the transaction establishment, producing a three-dimensional graph of the retry levels within the area of the transaction establishment, and determining, from the graph, subareas within the area having retry levels above a predetermined maximum retry level. Once the subareas having higher retry levels are determined, the locations of the transmit and receive antennas may be changed and/or interfering structures may be moved until the retry levels of the subareas are below the predetermined maximum retry level.

DeTemple et al., U.S. 5,995,015 describes a system for communicating between a store computer and locations in the les of a retail facility. A hard-wired grid connects the store

computer to a plurality of transceivers located in zones throughout the facility and the transceivers establish a wireless link to the locations. One embodiment is a product information display system in which the locations are fixed information display terminals, such as price displaying shelf tags. Another embodiment is an item tracking system, in which the locations are movable shopping carts or baskets.

Failing, Jr. et al., U.S. 6,016,481 describes an improved system for space management in retail stores. The space management system includes price display labels mounted on rails along the edges of shelves in a store. A communications link between the computer and the labels permits the computer to address each label by a logical address and to determine the physical location of each label to within a resolution of typically four feet. The system prepares price audit lists and adjacency audit lists that permit economical use of the time of store personnel during the audit. The lists are generated in such a way that the items on a particular list are physically contiguous; thus once the correct general area has been located by the auditor little additional time need be spent locating the individual items. In performing an audit of product facings, the user is able to use the display hardware, including the pushbutton on each label, as a data collection system for product facing information. In product location mode, the user starts at the first label at one end of a shelf and presses the button on the first label. The user moves to the second label, presses its button, moves to the third label, and the process is repeated for each label along the shelf, and for the rest of the shelves in the area being audited. This permits the system to collect information as to the sequence of labels along a rail.

Halperin et al., U.S. 6,105,004 describes a product monitoring system for monitoring a variety of products grouped according to their identities on shelves, including a central computer storing the identification of each group of products on the shelves; a plurality of electronic shelf labels, each located adjacent to a shelf for a group of products, communicating with the central computer, storing the identification of the respective group of products, displaying information relating to the respective group of products, and reading out the identification of the respective group of products; a plurality of portable units each to be carried by a user of the system; and a record memory for each portable unit. Each portable unit includes a read-in device capable of establishing a short-

range communication link with the read-out device of each electronic shelf label for reading in the product identification and for recording same in the record memory for the respective portable unit.

Sutherland, U.S. 6,253,190 describes a shelf tag comprising a liquid crystal display having optical states which are stable without power and an interface that allows for each character element to be programmed easily by sweeping a programming device across the character element contacts with all power and signal requirements being supplied to the shelf tag by the programming device. The programming device can be integrated with a portable transaction computer equipped with a bar code reader or can be embodied in a stand-alone apparatus capable of receiving user input, displaying information and interfacing to the shelf tags. A method of using the shelf tags, the programming device and a radio frequency computer local area network are presented which automates many typical business applications such as inventory updating and simultaneously changing prices advertised on the shelf tags.

Brick et al., U.S. 6,269,342 describes an electronic pricing and display system using programmable electronic shelf tags. Programmable electronic shelf tags are used in connection with apparatus for programming the electronic shelf tags. Pricing and product information is stored in databases of a computer system for such purposes as inventory control and updating pricing information. A portable programming device is used to transmit programming data Methods are provided for fast and convenient modification of large numbers of electronic shelf tags located throughout a facility (e.g., a retail store).

Gelbman, U.S. 2001/0020935 A1 describes smart and dumb implementations of a stand-alone, remotely updateable, remotely alterable, flexible electronic label. The electronic label provides for displaying information in connection with a mammal, non-mammal, an item or location. The label includes a display assembly having electronic ink disposed on a support, one or more antennas for sending or receiving signals corresponding to one of instructions, programs, data or selected indicia to be displayed by said display assembly, a storage element in circuit with the antenna for storing the instructions, programs, data and indicia, and one or more processors for intelligently determining the indicia to be

displayed by the display assembly, for controlling and coordinating operation of the label, and for generating output signals for instructing the display assembly to display the indicia.

Hook et al., U.S. 2001/0054005 A1 describes an electronic display tag system. The system has an electronic display tag including a display for displaying at least one of pricing data and product identification data, the display having bistable character elements or bistable pixels. The display tag has a decoder logic unit for decoding received programming data and for updating the display based on the programming data, the programming data being received wirelessly. The display tag also has a wireless transceiver, the wireless transceiver for converting a power-inducing signal transmitted wirelessly to the display tag into electrical power, the electrical power used by the decoder logic unit to update the display.

Gelbman, WO 00/16189 describes smart and dumb implementations of a stand-alone, remotely updateable, remotely alterable, flexible electronic label. The electronic label provides for displaying information in connection with a mammal, non-mammal, an item or location. The label includes a display assembly having electronic ink disposed on a support, one or more antennas for sending or receiving signals corresponding to one of instructions, programs, data or selected indicia to be displayed by said display assembly, a storage element in circuit with the antenna for storing the instructions, programs, data and indicia, and one or more processors for intelligently determining the indicia to be displayed by the display assembly, for controlling and coordinating operation of the label, and for generating output signals for instructing the display assembly to display the indicia.

Visible Tech-Knowledgy, LLC, WO 02/063602 describes smart and dumb implementation of a stand-alone, remotely updateable, remotely alterable, flexible electronic label. The flexibility of the electronic label allows the label to fit into and conform to the shape of the molding used in retail store shelving to display merchandize and warehouse shelving. The flexible, thin label includes a flexible display assembly having electronic ink disposed on a support, one or more antennas for sending or

receiving signals corresponding to one of instructions, programs, data or selected indicia to be displayed by the display assembly, a storage element in circuit with the antenna for storing the instructions, programs, data and indicia, and one or more processors for intelligently determining the indicia to be displayed by the display assembly, for controlling and coordinating operation of the label, and for generating output signals for instructing the display assembly to display the indicia.

Visible Techknowledgy, LLC, WO 02/071382 describes smart and dumb implementations of a stand-alone, remotely updateable, remotely alterable, flexible electronic label. The electronic label provides for displaying information in connection with a mammal, non-mammal, an item or location. The label includes a display assembly having electronic ink disposed on a support, one or more antennas for sending or receiving signals corresponding to one of instructions, programs, data or selected indicia to be displayed by said display assembly, a storage element in circuit with the antenna for storing the instructions, programs, data and indicia, and one or more processors for intelligently determining the indicia to be displayed by the display assembly, for controlling and coordinating operation of the label (16), and for generating output signals for instructing the display assembly to display the indicia.

Barritz et al., U.S. 20020008621 describes a system and method, which allows the identity of assets and their physical locations to be mapped and associated with one another. The invention includes a locator tool which receives an input which allows the tool to determine its own spatial location and thereby the spatial locations of various objects such as furniture, computer equipment, and structural components such as doors, windows to be identified and located and thereafter mapped in the form of architectural layout, diagrams, and the like. The invention is also an inventory system as well as a verification system that allows objects or assets to be inventoried, tracked, or verified against purchasing lists or the like.

Stanis et al., U.S. 4,135,241 describes a data handling system for a hospital or like establishment. The system keeps track of bed allocation, changes in inventory, and charges to patients, and also serves as a communication network for the hospital. Data is

fed into the system in the form of pre-punched cards bearing patient information, inventory data, and commands or messages, and thus unskilled personnel can quickly feed data into the system without error. Message data is routed directly to teleprinters at addressed locations. Bed allocation and patient data, and charge and inventory data are respectively stored in separate magnetic drum storage areas. Searching facilities are provided which can locate desired data entries in either storage area and mark these entries for printout, and separate printout circuitry then transfers marked data items to the proper addresses in the proper format. At the end of each day, a final search is performed which produces a printout of all charges organized by patient number. A tally inventory search is also performed which produces a printout of inventory changes organized by item number and by department number. The tally search is cumulative, and a tally arithmetic unit summarizes inventory data for each separate item before printout. A running record is kept of each day's total charges, credits, and payments on account in a central core memory, and this record is continually updated by a central arithmetic unit.

Guthrie, U.S. 5,565,858 describes a device, which locates a container from a group of containers utilizing an electronic tag; the electronic tag is capable of being positioned in close proximity to one of the containers. The electronic tag includes at least one long-range transceiver portion and at least one short-range transceiver portion. Each long-range transceiver portion is capable of communicating with either a short-range transceiver portion associated with another electronic tag, or an interrogator unit. Each short-range transceiver portion is capable of communicating with a long-range transceiver portion of another electronic tag. The device assists in locating a container, relative to other containers, when the containers are stored in a stacked or nested configuration. A global positioning system (GPS) can be utilized to locate the position of the containers on the Earth's surface.

Bunte et al., U.S. 5,873,070 describes an improved data collection system utilizing at least partially integrated data collection and gathering devices and related peripherals. The system includes an at least partially wearable data collection terminal, associated peripherals, and a communication system. The data collection system may utilize a wearable data collection terminal having a computer processor, associated memory,

inputs, and outputs. Associated peripheral devices may include voice inputs and outputs; an optically readable information set reader, a keyboard and/or touch-panel, intelligent-body-conforming battery packs, mass storage devices, user position and next task location device, a display, a printer, and a data communication system for both local area and wide area communication.

Woolley, U.S. 5,959,568 describes an object in a storage area or moving vehicle that is monitored by attaching an electronic tag to the object. An electronic device detects the presence of the object by communicating with the tag while the object is in storage or is being moved by the vehicle. The tags may also determine the location of an attached object and may reroute the object if it deviates from a given shipping schedule. A group of objects is monitored by two electronic tags, each attached to an object in the group. Each tag has circuitry for communicating information relating to an object in the group to a second tag. Each tag also includes a memory connected to the circuitry that is capable of storing the information, and a controller connected to the memory and the circuitry. A distance is measured by transmitting multiple symbols from one object to another object, having the symbols returned such that the symbols' measured round-trip times are not all identical, and calculating the distance using the measured round-trip times.

Amon et al., U.S. 5,960,413 describes a scanning radar unit or a phased array scanning radar unit, for the purposes of additionally obtaining unit interior topological information. Such interior information is required to determine an accurate tally count in the case where two or three boards such as, have been longitudinally aligned to span the entire board row of a given coarse (a technique referred to as "nesting"). In the case of scanning radar unit, this additional interior topology information is gathered by emitting a focused pulsed incident scanning energy beam, which is of an energy chosen to be transmissive to paper wrap materials which might be covering unit and to the lumber of unit itself. As beam transmits through "nested" boards such as it will encounter a board row break such as where the two boards are abutted. Either board end, which defines this break, will have been previously demarcated during unit construction by a reflective material. This reflective marking will cause the incident beam to reflect back towards scanning radar unit as reflective beam. The reflective information obtained by unit is

input to the unit interior topological processor which then determines the three dimensional locations of all board row breaks within lumber unit which is communicated to computer. Computer then combines this interior end surface information with the exterior information to provide a precise tally count of unit.

O'Callaghan et al., U.S. 6,311,892 describes Apparatus for automatically acquiring and verifying, relative to pre-established rules, information affixed to relatively flat articles transported along a transport path comprises weighing means for measuring weight of articles being processed, image acquisition means for acquiring a representation of indicia appearing on an article, processing means for recognition of the indicia appearing on an article, and processing means for verifying acquired data against the pre-established rules.

Salvo et al., U.s. 6,341,271 describes an inventory management system that automatically monitors inventory amounts, provides information concerning inventory, and decides if an order for replacement inventory should be placed. The system includes a storage for inventory, an indicator for monitoring and reporting the level of current inventory, and a controller for receiving information from different inventory suppliers and for integrating such information with information on current inventory amounts and estimated future use to decide if an order for replacing inventory should be made. An order is placed automatically to a supplier and the progress for the delivery of replacement inventory is automatically monitored. A method using this system for managing inventory includes the steps of automatic gathering information about the current inventory and deciding whether and when replacement inventory should be ordered.

Barnett, U.S. 6,343,276 describes a shoe size scanner system that is an automated system for use in retail stores, and particularly in shoe stores. The scanner system has a base unit which interfaces with the store's computerized inventory system, and a plurality of remote units, which interface with the base unit. The remote units include at least the input device of a bar code scanner, and may be either fixed mount or portable, handheld scanning units. The fixed mount units are positioned in fixed locations, such as display shelves or tables and may be used by either store clerks or customers. The handheld units

are intended for use by sales clerks, and may be supported by a neck strap, armband, or belt clip. According to the shoe size scanner system, each shoe on display in the store has a bar code affixed thereto which encodes an identifier number corresponding to the model of the shoe. Either a sales clerk or a customer may scan the bar code with the remote unit, which communicates with the base unit and returns identification of the shoe model. The sales clerk or customer may then select one of three function keys so that the remote unit will display, for that particular model, either (1) a list of all shoe sizes in stock; (2) a response indicating whether the shoe is in stock in a specified length and width; or (3) a list of all shoe widths in stock in a specified length. Price information for each shoe listed in the response is provided.

Engellenner, U.S. 6,388,569 describes a method and apparatus for location of objects to facilitate retrieval, filing, security, inventory stock-keeping and the like. The methods and apparatus employ a tag element associated with each object-to-be-located, and interrogation system for searching one or more spatial regions for such tagged items, as well as mechanisms for identifying objects within the interrogated region.

Norand Corporation, WO94/10774 describes an apparatus for a radio communication network having a multiplicity of mobile transceiver units selectively in communication with a plurality of base transceiver units which communicate with one or two host computers for storage and manipulation of data collected by bar code scanners or other collection means associated with the mobile transceiver units. The radio network is adaptive in that in order to compensate for the wide range of operating conditions a set of variable network parameters are exchanged between transceivers in the network. These parameters define optimized communication on the network under current network conditions. Examples of such parameters include: the length and frequency of the spreading code in direct-sequence spread spectrum communications; the hop frame length, coding, and interleaving in frequency-hopping spread spectrum communications; the method of source encoding used; and the data packet size in a network using data segmentation.

Creative Golf Designs, Inc., WO0077704 describes an inventory control system, which includes anti-collision, radio frequency identification apparatus or tags affixed to each item of an inventory and including a unique modulation code, an interrogator/reader that generates a field of sufficient range to activate each tag associated with each item of the inventory in communication with a computer. The computer includes a list comprising an identifier for each item in the inventory, the modulation code for the tag associated with each item in the inventory and an item status where the status indicates whether the item is present or absent.

The prior art teaches a smart electronic label employing electronic ink, a programmable shelf tagging system, a method of optimizing electronic price label systems, a remote electric information display system for retail facilities, a space management system for retail stores, a product monitoring system, a programmable shelf tag and method for changing and updating shelf tag information, and a programmable shelf tag and method for changing and updating shelf tag information. However, the prior art does not teach a smart label with two-way radio communication capability for use in a three-space locating system. The present invention fulfills these needs and provides further related advantages as described in the following summary.

SUMMARY OF THE INVENTION

The present invention teaches certain benefits in construction and use which give rise to the objectives described below.

The present invention uses a network of ultra wide band (UWB) units capable, as a group, of precisely locating objects in three-dimensional space as described in U.S. patents 6,400,754 and 6,385,268 to Fleming, and 6,300,903 to Richards. These "units" are able to determine their locations in reference to a give point in space. Miniature units may be built into electronic shelf labels as will be described below. Once activated, these Units become part of a UWB network. Such networks may comprise a wired or wireless simplex or full duplex electronic labeling system and is advantageously employed in stores and retail establishments. Each Unit is attached to an individual label; has its own

address and the label displays data received from a source such as a computer system. Typically such information will include any of: description of an item, unit price, price per weight unit, quantity in stock, special promotions, etc. In duplex systems the label responds with an acknowledgement when addressed.

The primary purpose of the present invention is to incorporate the information displayed in such an electronic labeling system with the ability to determine the accurate location of each label and to provide an interactive data storage capability, that includes not only the data displayed by the label but also its location. This enables a virtual map of a storage facility such as a retail store and provides significant advantages.

Such a system reduces the stocking process cycle time, cuts down on new store setup-time, improves stocking issues such as over or under stocking, and enables users to locate a specific stock item quickly. For on line shoppers, or from a store kiosk, locating items is very easy.

The Units are matched to labels and attached to shelves to identify specific stock items. The Units communicate with other units already in place so as to determine current location, as described in the prior art. Each label displays information pertaining to a specific stock item. The units communicate with the computer system to update the database with current location. Such updates can be performed on a regular schedule, when a unit detects a change in its location or per user request when trying to locate a specific item.

All physical fixtures, i.e. shelves, hooks, displays etc. are mapped as to exact size and location in the database. This results in the ability to create a "virtual" store layout.

To accomplish the present inventory control and identification system and method, the present invention provides a label adapted for attachment to inventory shelves and the like. The labels are adapted for displaying inventory information such as ID number, price, quantity, price per unit quantity and other information. Such information is displayed on the labels using liquid crystal display technology.

The label is enabled with an electronic pictorial display for identification of the inventory. A network of the units are set in a fixed position relative to the storage space and are enabled for wireless communication with the identification labels. A computer system is enabled for wireless communication with the units so as to remotely change the displays on the labels and to identify the locations of the labels.

A primary objective of the present invention is to provide a system and method of use that provides advantages not taught by the prior art.

Another objective is to provide such an invention capable of recording the nature and location in three-space, of items in an inventory stores.

A further objective is to provide such an invention capable of remotely changing information on inventory identity labels.

A still further objective is to provide such an invention capable of confirming status of the inventory markers or displays to a remote location.

The present invention may be used as an inventory control and management method for use in large inventory stores such as warehouses containing thousands of items. Such items may be of any type, such as automobiles, tires, hardware, tools, foodstuffs, and so on, and may be stored in a two-dimensional array, such as with automobiles on a sales lot, or in a three-dimensional array (in three-space) such as in aisles and racks. In modern warehouses, such racks may be tens of feet in height and it is important to determine where small items are in a warehouse that may consume a square city block or more, and be 20 to 30 feet in height.

To accomplish the inventory control and management method of the present invention provides a combination mobile device for reading labels and for communication (R&C). The R&C is used in an inventory stores. It is positioned for reading an inventory label affixed to an item of inventory in the store. A data file is created corresponding to the

label reading and includes a time stamp taken at the time of the reading. The data file is transmitted using radio transmission from the R&C to a receiver and is then imported into a computer data processor. A network of fixed distributed communication nodes (transceivers) is positioned over the inventory store for receiving temporal cyclic signature pulses from the R&C which are transmitted constantly. At least three of the communication nodes within communication range, at any time, of the R&C are used to preform a triangulation for locating the R&C, and the location of the R&C in three space is recorded. A corresponding time for each one of the signature pulses is likewise recorded. In this manner a record of the location of the R&C is maintained constantly, and by comparing the time of a given reading of the label with a corresponding time of the triangulation of the location of the R&C, it is possible to determine where any item is located within the stores.

Other features and advantages of the present invention will become apparent from the following more detailed description, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawing illustrates the present invention. In such drawing:

Figure 1 is a conceptual diagram of a preferred embodiment of the invention;

Figure 2 is a perspective view of an information label of the invention;

Figure 3 is a top plan view of a portion of a retail product having a conventional label with bar-code identifier and which is shown to correspond to the label of Fig. 2;

Figure 4 is a perspective view of the retail product on a shelf with the information labels mounted on the front of the shelf; and

Figure 5 is a data processor computer display showing stocked item locations in accordance with the invention.

DETAILED DESCRIPTION OF THE INVENTION

The above described drawing figures illustrate the invention in at least two of its preferred embodiments, which is further defined in detail in the following description.

The present invention is a system and method for the identification of inventory stocks wherein the location and identity of any stock may be determined and its identity tag changed; all from a remote location. The system uses a storage space 10 (Fig. 1), such as a warehouse, a supermarket, a parking garage, and a dead storage facility, and may be plural storage spaces 10 within a building, for instance, such as on different floors, or separate buildings. The storage space 10 receives a plurality of inventory or stock items 20 (Fig. 4) such as packages, food containers, vehicles and discarded or obsolete equipments; and may be any other type of item or item groups that are able to be sorted, stocked and identified. Identification labels 30 (Fig. 2), referred to throughout as simply "labels," are preferably rectangular in shape, but may be any shape, with a front display face 32 and a means for mounting 34, such as, for only one example, the track engagement device shown in Fig. 2, and as is well known in the supermarket industry. The mounting means 34 engages a receiver 36, such as the track shown in Fig. 4. The labels 30 are positioned in physical correspondence with the inventory items 20. Each of the labels 30 provides a first means for tranceiving 40 such as a miniature wireless radio frequency receiver and transmitter, as is well known in the art, and a presentation means 38 such as an electronic pictorial display, as for instance, a liquid crystal or other electronic display, also well known in the art. The presentation means 38 appears on the front display face 32 of the label 30. This is clearly shown in Fig. 2.

A coordinate network of a second means for transceiving 60 is preferably comprised of plural radio frequency receivers and transmitters with UWB transceiving capability, and

is mounted in a fixed position and orientation relative to the storage space 10. The second transceiving means 60 is enabled for wireless communication with the first transceiving means 40, and also with a data processing means such as a computer system 50, which is enabled for wave energy signal communication with both the first 40 and second 60 transceiving means.

In use, the system transmits wireless signals from the data processing means 50 to the first transceiving means 40; the signals corresponding to, and causing the pictorial representations of the inventory items to be displayed through the presentation means 38. Signals are sent, on demand, from the first transceiving means 40 to the data processing means 50 to confirm satisfactory operation of the identification labels as well as the specific information being displayed. The labels 30 are located in 3-space through any well known triangulation method using the coordinate network 60 as will be described with particular detail below.

To accomplish its objectives, communication in the present invention transmits digital information over relatively short distances, as allowed by FCC rules, employing any well known digital wireless communication technique as described in the prior art. Preferably, this wireless transmission of information is accomplished using low power, ultra wide band (UWB) communication signals which are particularly suitable in the present application, as will be shown. Other communication protocols that are well known in communication engineering could be used in place of UWB. Such communicating apparatus is so well known as to be easily duplicated in the present invention by those of skill in the art and is fully described in the incorporated references. In an alternate embodiment, a hand held label reading device using any well known optical, mechanical, electrical, electrostatic, or magnetic system for reading bar code or other contact or proximity coding system may be used for reading the labels 30. The inventory labels 30 may be radio tags, bar code labels or other well known tags capable of labeling inventory. A label reader 70 is preferably of the type that requires its position to be close to (proximity), or in contact with the label 30 to be read. Such proximity readers 70 include magnetic swipe types, RFID type, optical bar code types, and others. When the reader 70 is close to the label 30, or touching it, and when the communication

means is, likewise, very close, the accuracy of the location is improved. Therefore, it is a preferred technique to use a single, miniature hand-held device, shown as item 70 in Fig. 1, with contact or proximity (non-contact) label reading and communication capabilities. This technique is fully described in the priority documents to this application and these application documents are hereby incorporated into this application by reference.

A common need in inventory management is to determine the nature or identity of inventory items and also their location, and the present methods accomplish this economically and efficiently. A data file or database 52 is established in the computer system 50, and this file corresponds to the information displayed by labels 30. This step is known, for instance, in the supermarket and grocery trade, each time an item is scanned at a checkout counter, its identity is recorded in a data file, which is then imported into a database and the current known inventory count of the item is reduced by one. Similarly here, the data file is transmitted by wireless communication, as described above and shown in Fig. 1, from the labels 30, of which there may be hundreds, to the computer system 50. In like manner, triangulation data signals are preferably sent by wireless means, or over wires means 62 to the computer system 50 where label 30 location information is then stored as records. Such a record, beside location information, will contain information such as, item description, item serial or stocking number, item count or quantity, item date, and so on. The record also contains the date and time of day that the reading took place. The data base 52 may contain hundreds, or many hundreds of such records, and the means for creating such a database and of importing information, such as described here, is very well known in the art.

The coordinate network of nodes 60 is preferably a plurality of fixed distributed communication nodes positioned over or near the inventory items 20. Each of the communication nodes, as previously described, is preferably an electrical signal unit device with antenna, capable of both receiving and transmitting wireless electrical signals. Such devices are extremely inexpensive when employed for low power and limited range applications making such a system possible. The number of nodes 60 required in the present method will depend upon the size of the inventory stores, the output power, signal to noise ratio in the communication channel space, and other factors

well known to communications engineers. Physically, the nodes 60 may be mounted on or from a ceiling of a warehouse, or other building structure, or may be mounted on a network of wires strung or hung from a ceiling or from poles in an indoor or out of doors stores and this is well known in the art. In the preferred embodiment, shown in Fig. 1, the nodes 60 are wireless transceivers interconnected by electrical conductors 62 for sharing information. The wireless transmitted signals are able to use ultra low power, being transmitted at roughly four orders of magnitude below typical output power rating for conventional RF transmissions. By precisely timing these transmissions, and by using matched antennas at the nodes 60, highly efficient communication is possible, as is described in the references. Because a wide spectrum is used, the UWB technique is only able to be employed locally to avoid interference with common carriers. On the other hand, such UWB signals are typically immune to local interference which takes up only a small portions of the radio spectrum. As stated, the UWB signals are received by any of the nodes 60 that are within range of a signal. Location information contained in the UWB signals is sent to the computer system 50 where such information from at least three nodes 60, enables the determination of the location of specific labels 30 in three-space through triangulation technique. In one embodiment, the triangulation method for locating the labels 30 uses discrimination of received time of the signature signals to determine location. This approach requires that the clocks of the nodes 60 be exactly synchronized.

The process, in one exemplary enablement, proceeds as follows: the computer system 50 transmits a location request signal with a label identification code. All of the labels 30 receive this request signal. The label 30 that corresponds to the identification code responds by transmitted a short burst signal containing the label's identification code and a time stamp, i.e., time of transmission. All other labels 30 do not respond. Each of the fixed nodes 60 that are within range of the responding label 30 receives the label's signal burst, and upon receipt, time stamp the burst. The label's and the node's time stamps are then transmitted to the computer system 50 for computation. Since the exact locations of the nodes 60 are known, and the time of flight of the label's signal burst is able to be easily calculated from the time stamps, the exact location in 3-space of the corresponding

label 30 is calculated. Since the entire process takes only a few microseconds, a complete inventory of thousand of labels 30 may be located in a few seconds.

As an example of this triangulation technique, the location of any label 30 (any one of the many labels in the apparatus) is determined when label 30 is caused to emit a short burst of energy, e, at time t^0. This burst is in response to a signal request from the computer system 50. The burst, e, carrying its signature, "id", is received by at least three nodes 1, 2 and 3 (second transceiver means 60) whose locations are exactly defined in the inventory space. The instant in time that the nodes receive e is identified, i.e., the nodes have clocks on board and the instant a signal is received is noted by such clocks, the time being attached digitally to the signature of the signal received. In the present case, the receipt times are $t^{1,}$, t^2 and t^3 respectively. Assuming that the three nodes 60 are at different distances from the label 30, these three times $t^{1,}$, t^2 and t^3 will be distinct. The computer system 50 may not know that e was emitted depending on the ability of receiver 54 to pick up this low energy signal. However, since the burst e contains the time stamp t^0 each of the three nodes is able to read the initial time stamp and transmit, by cables 62: t^0 t^1 and t^0 t^2 and t^0 t^3 to the computer system 50. Since the velocity of propagation, v, of the signals through space is known, the distance of the label 30 from each of the nodes is calculated as: $d^1=v/(t^1 - t^0)$ and $d^2=v/(t^2 - t^0)$ and $d^3=v/(t^3-t^0)$. Now, by defining circles about nodes 1, 2 and 3 with radiuses equal to d^1, d^2 and d^3 respectively, the location of label 30 is identified by the point of intersection of the three circles. This calculation is easily carried out on the computer system 50 as is well known in the art and is the results may be precise.

Alternately, the triangulation method may use signal direction discrimination of the signature signals to determine location. This approach uses antenna systems that are able to distinguish within small tolerances, the direction from which a signal is received and this is well known in the art. Again a triangulation is accomplished from the label's burst signal. The foregoing discussion uses equipment, parts and techniques that are well known in the art.

The present invention makes it possible to access the current information presented by any of thousands of labels 30, make changes to the label's display or shut the label display off.

The present method further comprises the step of composing a pictorial map 100, as shown in Fig. 5, of the inventory items in the storage space, as derived from the calculated locations of the labels 30. Such computer graphic maps are well known in the art. The method further comprises the step of identifying any one of the labels 30 on the pictorial map by an indication as shown in Fig. 5 at column "D," line 3, on the map 100. Such a map may be printed, as shown in Fig. 1, by printer 80 and posted or distributed for use by employees, customers, etc.

It should be recognized that the present location discrimination system and technique described herein may be used with the smart labels described, or with existing smart labels described in the references, and also with standard "dumb" labels.

In an alternate embodiment, the present invention is a method wherein a combination mobile means 70 for reading labels 30 and for communication is employed. One such device or hundreds may be used at the same time depending on the size and nature of the inventory management objective. In this description, we refer to a single read and communicate device (R&C) 70, but it should be realized that plural units would normally be employed simultaneously in the present method. The communication means of the R&C 70 provides two wireless functions. To accomplish its objectives it transmits digital information over relatively short distances, as allowed by FCC rules, employing any well known and common analog or digital wireless communication technique as described in the prior art. Preferably, however, it is able to transmit a low power ultra wide band (UWB) communication signal which is particularly suitable in the present application, as will be shown. Likewise, the label reading part of the R&C 70 may be any well known optical, mechanical, electrical, electrostatic, or magnetic system for reading bar code or other printed coding as described above. Such inventory labels may be radio tags, bar code labels and other well known tags capable of labeling inventory. However, the R&C 70 must be of the type that requires its position to be quite close or in

contact with the label 30 to be read. Such proximity readers include magnetic swipe types, optical bar code types, RFID types and others. Proximity is necessary because the position of the R&C 70 defines the location of the label 30. When the R&C 70 is close to the item of stock or inventory (carrying the label 30), or touching it, the accuracy of the location determination is improved.

The method includes the step of manually positioning the R&C 70 for taking a reading, and then taking a reading of an inventory label 30 or other indicia affixed to, or adjacent to, a selected inventory item 20 in an inventory stores. This process may be repeated for one item after the next until an entire inventory of stores is taken, or it may be completed for only one or a few items as desired. A common need in inventory management is to determine the nature or identity of inventory items and also their location, and the present method can accomplish this economically and efficiently. The next step in the present invention method is to create a data file in the R&C 70 corresponding to the label reading and a corresponding first time stamp taken at the time of the label reading. Thus, the R&C 70 has a data file creating capability of any type known in the art, and also has a time stamping capability, as is also well known in the art. This step is known, for instance, in the supermarket and grocery trade, each time an item is scanned at a checkout counter, its identity is recorded as a data file, which is then imported into a database and the current known inventory count of the item is reduced by one as was defined above. Similarly here, the data file is transmitted by wireless communication, as described above and shown in Fig. 1, from the R&C 70 to a receiver 54 using any well known method of moving data from a point of origin to a point where analysis will be conducted, and preferably employs digital wireless transmission. In like manner, the data file is transported, usually over an electrical cable, from the receiver 54 to a first data processor 50 such as any digital computer where the data file is stored in a database as a record. Such a record will contain information such as, item description, item serial or stocking number, item count or quantity, item date, and so on. The record also contains the date and time of day that the reading took place. The data base may contain hundreds, or many hundreds of such records, and the means for creating such a database and of importing information, such as describe here, into the database is very well known in the art.

A further aspect of the present invention is to provide the previously described network of fixed distributed communication nodes 60 positioned over or near the inventory stores. In addition to transmitting scan information to the receiver 54, the R&C 70 also emits a UWB pulsed signal on a continuous basis. UWB transmission packages digital information, in the present case, the identity of the R&C 70, that is contained in very short pulses transmitted over a wide swath of spectrum rather than at a specific frequency. Preferably, single UWB monocycles are transmitted from the R&C 70 antenna and by precisely positioning these monocycles in time and using matched antennas at the nodes 60, highly efficient communication is possible. As stated, the UWB signals are received by any of the nodes 60 that are within range of an operating R&C 70. As stated, preferably a constant stream of pulsed UWB signals is being transmitted by the R&C 70 and received by the nodes 60. Upon receipt, the UWB signals receive a second time stamp, or the UWB signal itself may contain the time stamp from the R&C 70. Information contained in the UWB signals are sent to a second data processor 50 or computer where the UWB information from at least three nodes 60, enable a determination of the location of the R&C 10 in three-space through triangulation as previously described. The UWB signals are then communicated, either wirelessly or over wires 62 in Fig. 1 to the second data processor 50 where the time of receipt at each of the three nodes 60 is used to determine the distance to the recorded item from each of the nodes 60 and then the point in three-space where the item 30 is located.

In this manner, the second data processor 50 calculates and records in a second data base, a running account of the locations of the R&C 40 over time and the location information is recorded with date and time. The location of the R&C 40 over the entire time that it is operating (transmitting) is preferably recorded.

To determine the location and identity of an label 30 within inventory stores, it now is possible to call-up the record of the label 30, in the first database 52 to determine item identity and time of record, and then by matching the time of location in the second database 52 to the time of record, to obtain location. A report may be then printed to show item identity and location.

While the invention has been described with reference to at least one preferred embodiment, it is to be clearly understood by those skilled in the art that the invention is not limited thereto. Rather, the scope of the invention is to be interpreted only in conjunction with the appended claims.

CLAIMS

What is claimed is:

1. An inventory control and identification apparatus comprising: a storage space for receiving a plurality of inventory items; identification labels positioned in physical correspondence with the inventory items; each of the identification labels providing a first tranceiving means and a presentation means, the presentation means enabled with an electronic pictorial display; a coordinate network of second tranceiving means in a fixed position relative to the storage space and enabled for wireless communication with the first tranceiving means; and a data processing means enabled for wave energy signal communication with the first and second tranceiving means; the presentation means enabled for presenting pictorial representations of the inventory items to provide identification and selection thereof.
2. The apparatus of claim 1 wherein the storage space is one of a warehouse, a supermarket, a parking garage, and a dead storage facility.
3. The apparatus of claim 1 wherein the inventory items are one of packages, food containers, vehicles and discarded obsolete equipments.
4. The apparatus of claim 1 wherein the identification labels are rectangular in shape with a front face and a means for engaging a track.
5. The apparatus of claim 1 wherein the first tranceiving means is a miniature radio frequency receiver and transmitter.
6. The apparatus of claim 1 wherein the presentation means is a liquid crystal display.
7. The apparatus of claim 1 wherein the second transceiving means is a plurality of radio frequency receivers and transmitters with UWB capability.
8. The apparatus of claim 1 wherein the data processing means is a computer system.
9. The apparatus of claim 1 wherein the pictorial representations are descriptions related to the inventory items.
10. An inventory control and identification apparatus comprising: a storage space for receiving a plurality of inventory items; identification labels positioned in physical correspondence with the inventory items; each of the identification labels associated with a first means for tranceiving; a coordinate network of a second means for

tranceiving in a fixed position relative to the storage space and enabled for wireless communication with the first transceiving means; and a computer system enabled for wave energy signal communication with the first and second transceiving means; the identification labels presenting pictorial representations of the inventory items to provide identification and selection thereof, the first and second transceiving means and the computer system enabled for locating of any of the labels.

11. An inventory control and identification method comprising the steps of: providing a plurality of inventory items in a storage space; positioning identification labels in physical correspondence with the inventory items; combining a first tranceiving means and an electronic pictorial presentation means with each one of the identification labels; positioning a coordinate network of second tranceiving means in a fixed position relative to the storage space and enabling the first and second transceiving means for mutual wireless communication; establishing a data processing means in wave energy signal communication with the first and second transceiving means; and transmitting signals from the data processing means to the first transceiving means, the signals corresponding to pictorial representations of the inventory items; presenting the pictorial representations on the presentation means to enable identification and selection of the inventory items.

12. The method of claim 11 further comprising the step of transmitting signals from the first transceiving means to the data processing means to confirm satisfactory operation of the identification labels.

13. The method of claim 11 further comprising the step of transmitting signals from the first transceiving means to the data processing means to confirm identity of the inventory items related thereto.

14. The method of claim 11 further comprising the step of locating the identification labels through a triangulation method using the coordinate network of the second transceiving means.

15. An inventory control and identification method comprising the steps of: providing a plurality of inventory items in a storage space; positioning identification labels in physical correspondence with the inventory items; combining a first tranceiving means and an electronic pictorial presentation means with each one of the identification labels; positioning a coordinate network of second transceiving means

in a fixed known position relative to the storage space and enabling the first and second transceiving means for mutual wireless communication; establishing a computer system in wave energy signal communication with the first and second transceiving means; and transmitting signals from the data processing means to the first transceiving means, the signals corresponding to pictorial representations of the inventory items; presenting the pictorial representations on the presentation means to enable visual identification and selection of the inventory items; transmitting a request coded for a selected one of the identification labels; emitting a time stamped transmission by the selected one of the identification labels; receiving the time stamped transmission by at least three of the second transceiving means of the coordinate network; identifying the time of receipt of the emitted time stamped transmission at the at least three second transceiving means; receiving the emitted time and received times of the time stamped transmission at the computer system; and calculating the location of the selected one of the identification labels.

16. The method of claim 15 further comprising the step of composing a pictorial map of the inventory items within the storage space from the calculated locations of the labels.

17. The method of claim 16 further comprising the step of identifying any one of the labels on the pictorial map.

18. An inventory control and management method comprising the steps of: providing a combination mobile means for reading labels and for communication (R&C); for at least one of a plurality of inventory items, positioning the R&C for reading an inventory label affixed to one of the inventory items in an inventory stores; creating a data file in the R&C corresponding to the label reading and a corresponding time stamp taken at the time of the label reading; transmitting the data file with the time stamp, from the R&C to a receiver; importing the data file from the receiver to a data processor; providing a network of fixed distributed communication nodes in proximity to the inventory stores; receiving a stream of signature UWB transmissions from the R&C at a plurality of the communication nodes; triangulating and recording the location of the R&C in three space at the time of the label reading, and storing location and identity information in a database for use in controlling and managing the inventory items.

19. The method of claim 18 further comprising the step of combining the mobile means for reading labels and the means for communication in such mutual proximity as to be physically indistinguishable in three-space.

20. The method of claim 18 further comprising the step of converting the signature transmissions into a history file defining the movements of the R&C over time.

21. The method of claim 18 further comprising the step of time stamping the signature transmissions from the R&C.

22. The method of claim 18 further comprising the step of time stamping the signature transmissions upon receipt by the communication nodes.

23. The method of claim 22 further comprising the step of discriminating received time of signature signals at, at least three of the communication nodes, to determine location of the R&C in three-space.

24. The method of claim 18 further comprising the step of signal direction discriminating of the signature signals at, at least three of the communication nodes, to determine location of the R&C in three-space.

AMENDED CLAIMS

[Received by the International Bureau on 30 September 2003 (30.09.03) original claims 1,10,11 and 14 amended, new claims 25-29 added; remaining claims unchanged]

After the present amendment, the claim set of the present application is as follows:

1. (Currently Amended) An inventory control and identification apparatus comprising: a storage space for receiving a plurality of inventory items; identification labels positioned in physical correspondence with the inventory items; each of the identification labels providing a first tranceiving means and a presentation means, the presentation means enabled with an electronic pictorial display; a coordinate network of second tranceiving means in a fixed position relative to the storage space and enabled for wireless communication with the first tranceiving means in a manner for triangulating the location of the first tranceiving means using time of signal travel; and a data processing means enabled for wave energy signal communication with the first and second tranceiving means; the presentation means enabled for presenting pictorial representations of the locations of inventory items to provide identification and selection thereof.
2. (Original) The apparatus of claim 1 wherein the storage space is one of a warehouse, a supermarket, a parking garage, and a dead storage facility.
3. (Original) The apparatus of claim 1 wherein the inventory items are one of packages, food containers, vehicles and discarded obsolete equipments.
4. (Original) The apparatus of claim 1 wherein the identification labels are rectangular in shape with a front face and a means for engaging a track.
5. (Original) The apparatus of claim 1 wherein the first tranceiving means is a miniature radio frequency receiver and transmitter.
6. (Original) The apparatus of claim 1 wherein the presentation means is a liquid crystal display.
7. (Original) The apparatus of claim 1 wherein the second transceiving means is a plurality of radio frequency receivers and transmitters with UWB capability.
8. (Original) The apparatus of claim 1 wherein the data processing means is a computer system.
9. (Original) The apparatus of claim 1 wherein the pictorial representations are descriptions related to the inventory items.
10. (Currently Amended) An inventory control and identification apparatus comprising: a storage space for receiving a plurality of inventory items; identification labels positioned in physical correspondence with the inventory items; each of the

identification labels associated with a first means for trancciving; a coordinate network of a second means for tranceiving in a fixed position relative to the storage space and enabled for wireless communication with the first transceiving means; and a data processing means enabled for wave energy signal communication with the first and second transceiving means; the identification labels presenting pictorial representations of the inventory items to provide identification and selection thereof, the first and second transceiving means and the computer system enabled for locating the labels in three-space through one of time stamp triangulation using time of signal travel, and signal direction discrimination triangulation.

11. (Currently Amended) An inventory control and identification method comprising the steps of: providing a plurality of inventory items in a storage space; positioning identification labels in physical correspondence with the inventory items; combining a first tranceiving means and an electronic pictorial presentation means with each one of the identification labels; positioning a coordinate network of second tranceiving means in a fixed position relative to the storage space and enabling the first and second transceiving means for mutual wireless communication; establishing a data processing means in wave energy signal communication with the first and second transceiving means; and transmitting signals from the data processing means to the first transceiving means, the signals corresponding to pictorial representations of the inventory items; presenting the pictorial representations on the presentation means to enable identification and selection of the inventory items and identifying locations in three-space of the inventory items by one of time stamp triangulation for time of signal travel calculation and signal direction discrimination triangulation.

12. (Original) The method of claim 11 further comprising the step of transmitting signals from the first transceiving means to the data processing means to confirm satisfactory operation of the identification labels.

13. (Original) The method of claim 11 further comprising the step of transmitting signals from the first transceiving means to the data processing means to confirm identity of the inventory items related thereto.

14. (Currently Amended) The method of claim 11 further comprising the step of locating the identification labels through a triangulation method using the coordinate network of the second transceiving means and ultra-wide-band signal transmissions.

AMENDED SHEET (ARTICLE 19)

15. (Original) An inventory control and identification method comprising the steps of: providing a plurality of inventory items in a storage space; positioning identification labels in physical correspondence with the inventory items; combining a first tranceiving means and an electronic pictorial presentation means with each one of the identification labels; positioning a coordinate network of second transceiving means in a fixed known position relative to the storage space and enabling the first and second transceiving means for mutual wireless communication; establishing a computer system in wave energy signal communication with the first and second transceiving means; and transmitting signals from the data processing means to the first transceiving means, the signals corresponding to pictorial representations of the inventory items; presenting the pictorial representations on the presentation means to enable visual identification and selection of the inventory items; transmitting a request coded for a selected one of the identification labels; emitting a time stamped transmission by the selected one of the identification labels; receiving the time stamped transmission by at least three of the second transceiving means of the coordinate network; identifying the time of receipt of the emitted time stamped transmission at the at least three second transceiving means; receiving the emitted time and received times of the time stamped transmission at the computer system; and calculating the location of the selected one of the identification labels.
16. (Original) The method of claim 15 further comprising the step of composing a pictorial map of the inventory items within the storage space from the calculated locations of the labels.
17. (Original) The method of claim 16 further comprising the step of identifying any one of the labels on the pictorial map.
18. (Original) An inventory control and management method comprising the steps of: providing a combination mobile means for reading labels and for communication (R&C); for at least one of a plurality of inventory items, positioning the R&C for reading an inventory label affixed to one of the inventory items in an inventory stores; creating a data file in the R&C corresponding to the label reading and a corresponding time stamp taken at the time of the label reading; transmitting the data file with the time stamp, from the R&C to a receiver; importing the data file from the receiver to a data processor; providing a network of fixed distributed communication

AMENDED SHEET (ARTICLE 19)

nodes in proximity to the inventory stores; receiving a stream of signature UWB transmissions from the R&C at a plurality of the communication nodes; triangulating and recording the location of the R&C in three space at the time of the label reading, and storing location and identity information in a database for use in controlling and managing the inventory items.

19. (Original) The method of claim 18 further comprising the step of combining the mobile means for reading labels and the means for communication in such mutual proximity as to be physically indistinguishable in three-space.
20. (Original) The method of claim 18 further comprising the step of converting the signature transmissions into a history file defining the movements of the R&C over time.
21. (Original) The method of claim 18 further comprising the step of time stamping the signature transmissions from the R&C.
22. (Original) The method of claim 18 further comprising the step of time stamping the signature transmissions upon receipt by the communication nodes.
23. (Original) The method of claim 22 further comprising the step of discriminating received time of signature signals at, at least three of the communication nodes, to determine location of the R&C in three-space.
24. (Original) The method of claim 18 further comprising the step of signal direction discriminating of the signature signals at, at least three of the communication nodes, to determine location of the R&C in three-space.
25. (New) An inventory control and identification apparatus for use with a plurality of inventory items in a storage space, the apparatus comprising: identification labels positioned in physical correspondence with the inventory items, each of the identification labels providing an electronic pictorial presentation means and a first tranceiving means; a coordinate network of second transceiving means in a fixed known position relative to the storage space; a data processing means; the first and second transceiving means and the computer system enabled for mutual wireless communication; the data processing means enabled for transmitting signals corresponding to pictorial representations of the inventory items to the first transceiving means; the electronic pictorial presentation means enabled for presenting the pictorial representation signals from the data processing means to

enable visual identification and selection of the inventory items; the data processing means enabled for transmitting a request signal coded for a selected one of the identification labels; the selected one of the identification labels enabled for emitting, in response thereto, a time stamped transmission; at least three of the second transceiving means enabled and positioned for receiving the time stamped transmission and for identifying the time of receipt of the emitted time stamped transmission; the data processing means enabled for receiving the emitted time and received times of the time stamped transmission and for calculating the location of the selected one of the identification labels.

26. (New) The apparatus of claim 25 wherein the data processing means is enabled for composing a pictorial map of the inventory items within the storage space from the calculated locations of the labels.

27. (New) The apparatus of claim 26 wherein the data processing means is further enabled for identifying any one of the labels on the pictorial map.

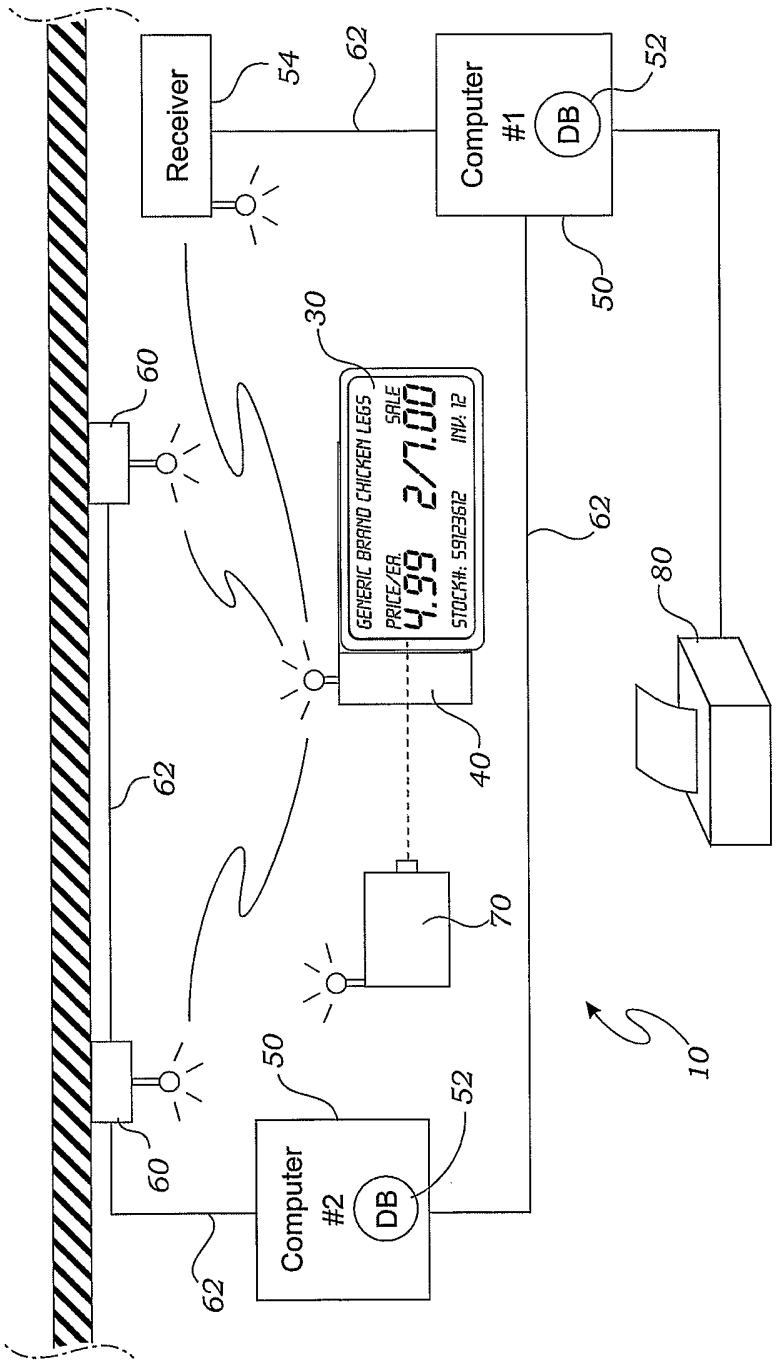
28. (New) An inventory control and management apparatus comprising in combination: a mobile means enabled for reading labels in an inventory stores and for communication; a data file and a corresponding time stamp within the mobile means for each label reading; a network of fixed distributed communication nodes in proximity to the inventory stores; the mobile means enabled for transmitting, and the network and a data processing means enabled for receiving a stream of signature UWB transmissions from the mobile means; the data processor enabled for using the signature transmissions and receipt time stamps of the network through triangulation to determine the location of the mobile means in three space for controlling and managing the inventory items.

29. (New) An inventory control and management apparatus comprising in combination: a mobile means enabled for reading labels in an inventory stores and for communication; a data file and a corresponding time stamp within the mobile means for each label reading; a network of fixed distributed communication nodes in proximity to the inventory stores; the mobile means enabled for transmitting, and each of a plurality of separate nodes of the network enabled for receiving, signature UWB transmissions from the mobile means, each of the separate nodes enabled for signal direction discrimination so as to identify the direction of transmission of the

signature transmissions; and a data processing means; the data processing means enabled for using the signature transmissions and discriminated direction information of the network through triangulation to determine the location of the mobile means in three space for controlling and managing the inventory items.

STATEMENT UNDER ARTICLE 19 (1)

The international search report indicated that Zimmerman et al and, Reynolds et al each prevented the finding of an inventive step in claims 1-14 and Evans et al and Blair et al each prevented the finding of an inventive step in claim 7. Claims 1, 10, 11 and 14 have been further narrowed to include the limitation of time of signal travel triangulation and/or signal direction discrimination triangulation which claim is noted as unobvious. It is therefore expected that claims 1-29 are now in condition for allowance. The claims have not been renumbered, but each claim is identified as "new," "currently amended," or "original."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62
Computer
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50
30
60
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2/7.00
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Computer
#2
DB
52
60
62

Fig. 1

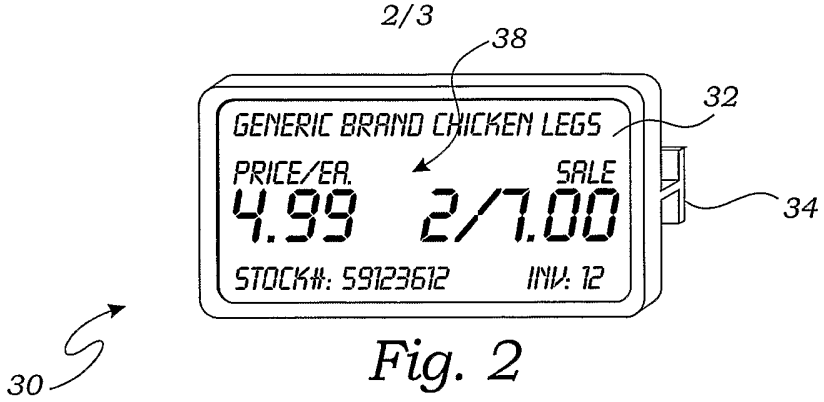


Fig. 2

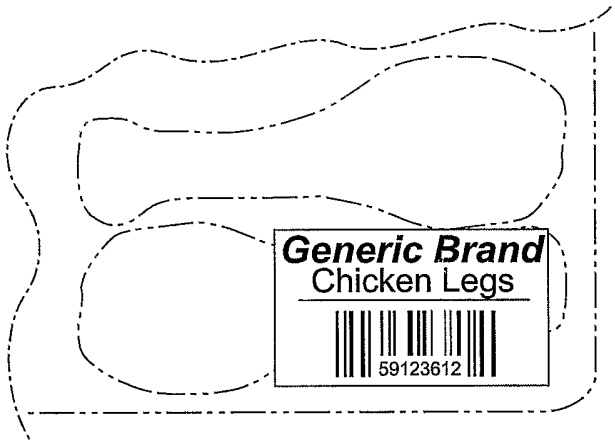


Fig. 3

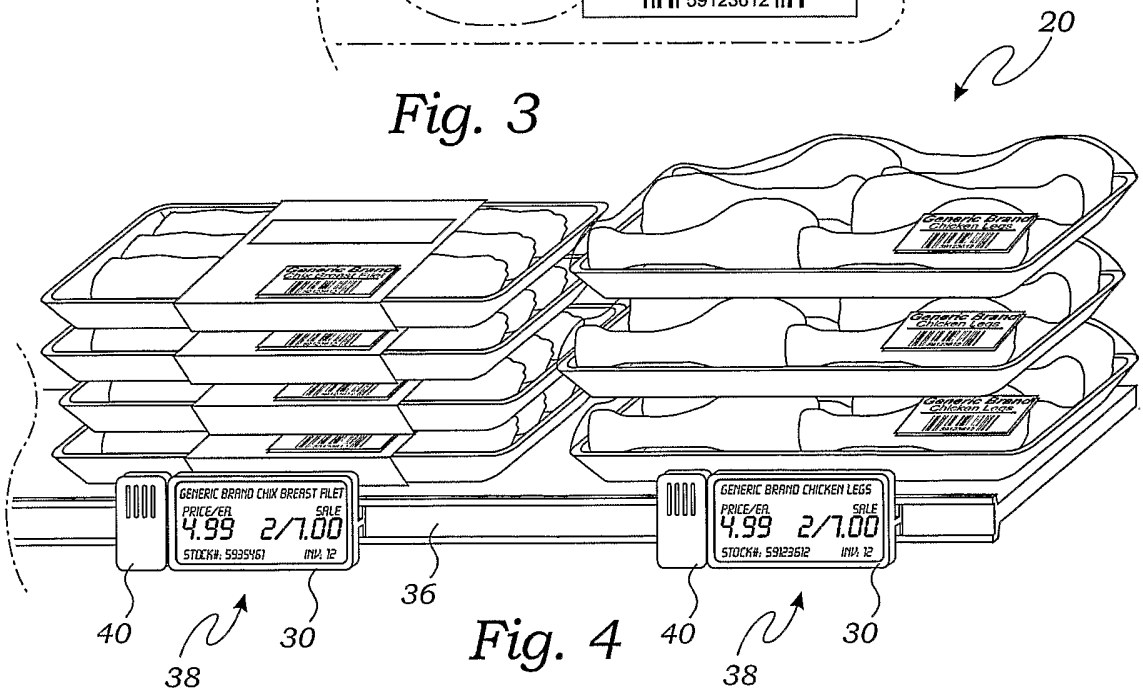
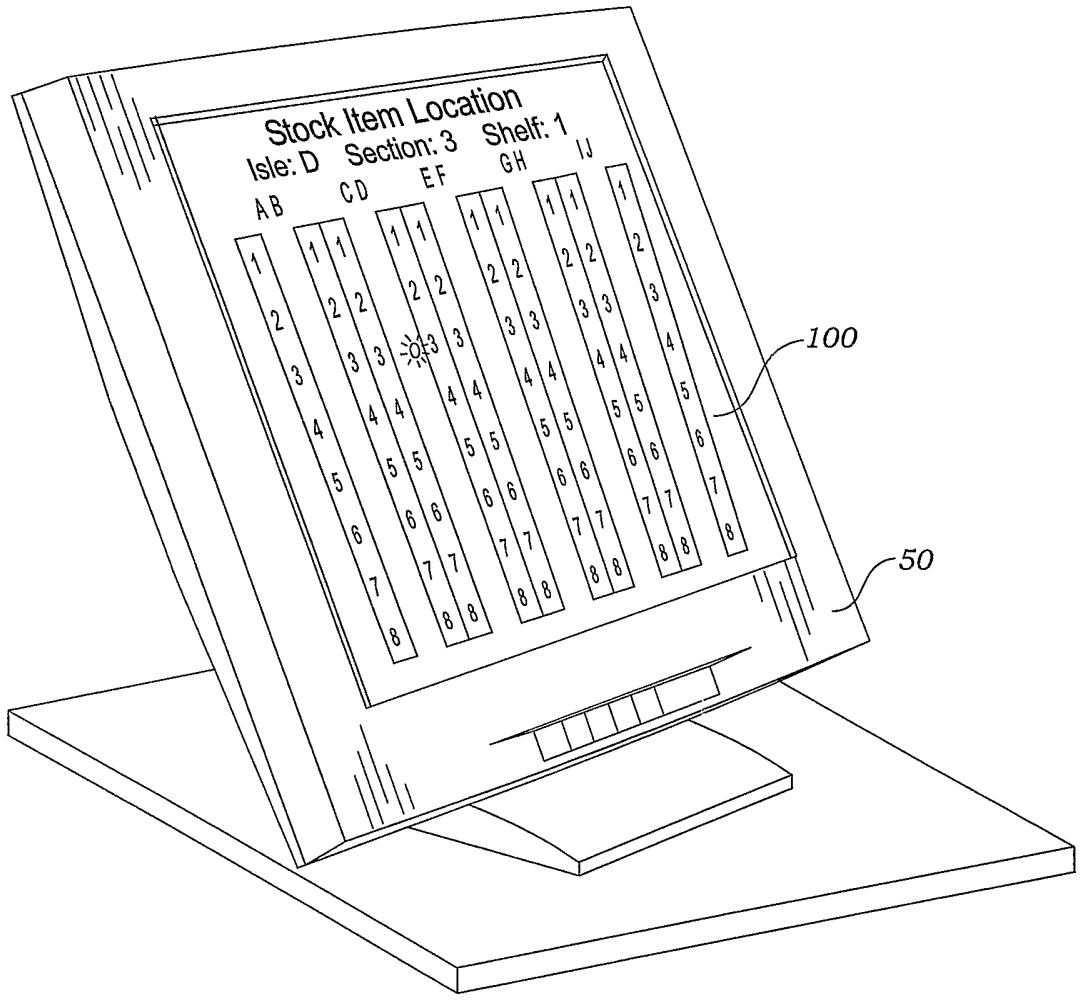


Fig. 4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AB CD EF GH IJ
100
50

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/09020

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : G06K 15/00
US CL :235/383
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Please See Extra Sheet.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,046,682 A (Zimmerman et al) 4 April 2000, figures 1-7, col. 1, lines 19-39, col. 1, line 56 - col. 2, line 13, col. 2, line 53 - col. 3, line 45, col. 3, line 60 - col. 5, line 40.	1-14
Y	US 6,318,636 B1 (Reynolds et al) 20 November 2001, figures 1, 2, col. 1, lines 8-11, 26-40, col. 2, lines 25-51, col. 3, line 44 - col 4, line 47, col. 5, lines 27-67.	1-14
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[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
05 MAY 2003	20 AUG 2003
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer JARED J. FUREMAN Telephone No. (703) 305-0427

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/09020

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 424 264 B1 (Giraldin et al) 23 July 2002, see entire document.	15-24
A	JP 2001-5872 A (Shinji) 12 January 2001, see entire document.	1-24
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International application No.
PCT/US03/09020

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

235/383, 375, 384, 385, 462.01, 462.13, 462.45, 462.44, 462.46, 470, 472.01, 472.02; 705/22, 28; 340/572.1, 572.4, 825.36, 14.1, 505, 573.1, 825.49; 342;450, 42, 50, 451, 463, 465; 700/213, 214, 215, 225, 226; 600/300

B. FIELDS SEARCHED
Electronic data bases consulted (Name of data base and where practicable terms used):

USPAT, USPGPUB, EPO, JPO, DERWENT, IBM TDB, IEEE XPLORE
search terms: tag, label, epl, electronic price label, esl, electronic shelf label, locate, location, position, timestamp, time stamp