Dynamic Barcode Display: Using an Optical Display to Present Updatable Barcode Data for Scanning by a Barcode Reader

By

Douglas Clark, Ph.D.

Paedia LLC

Background—Prior Art--Barcodes

More than 100 kinds of barcodes are in use today. They are mainly used to identify objects. Various standards such as the Universal Product Code (UPC) and European Article Number (EAN) specify barcode symbologies for use in retail, healthcare, foods, etc. Barcodes comprise two main types, linear or 1-D, and area or 2-D, also called "matrix" barcodes. Barcodes are generally printed on objects or on labels that are affixed to objects. Most comprise black marks on a white background. In the past, individual marks within barcodes have been printed in different colors. The use of a plurality of colors increases the amount of information that is contained in a barcode.

When it is desired to read and interpret the information in a barcode, image-receptive optical devices called barcode readers are used. Barcode readers are available in many configurations. Some use scanning laser beams to illuminate and then receive reflected light from the marks in a 1-D barcode in serial fashion. Other barcode readers are camera-like devices that receive reflected-light images of entire barcodes in a single image. Barcode readers typically interface with a computer terminal via a hard-wired electrical cord or a wireless connection such as well-known Bluetooth technology, WiFi, or the like. In all cases, once a barcode is scanned, i.e., when its image is received by a barcode reader, the image is interpreted by digital logic associated with the barcode reader to reveal the information contained within the barcode. Representative barcode readers are the Gryphon L GD4300, sold by Datalogic S.P.A., of Italy, the DataMan 8600 Series Barcode Reader sold by Cognex Corporation, of Natick, MA, U.S.A.

In the following, a specific example demonstrates use of barcodes in a healthcare situation. This example is not intended to be limiting in any way. The technology taught herein applies equally well to any system and apparatus that can display and read updatable barcodes of any kind. In some applications, a 1-D barcode is used. In other applications, a 2-D barcode is used. Although a particular code is described below, any other 1-D or 2-D barcode can be used instead of or in addition to the codes shown. It is assumed that a barcode reader that is used is capable of reading the barcode in use and communicating with a computing device capable of interpreting the information contained in the barcode.

Background—Prior Art—An Example—Barcodes used in hospital and clinic settings

Hospitals, clinics, and medical offices have long used barcodes to store and retrieve patient information such as patent identification and other indicia. More recently, well-known Quick Response (QR) codes are used to identify a patient's identification (ID), medications given to a patient, laboratory specimens, and much more. QR codes are described in detail in an article by the International Organization for Standardization at: https://www.iso.org/obp/ui/#iso:std:iso-iec:18004:ed-3:v1:en. Generation of QR codes is described at various locations on the Internet, including https://github.com/zxing/zxing. Reading of QR codes is described at various locations on the Internet, including http://dsynflo.blogspot.com/2014/10/opencv-qr-code-detection-and-extraction.html.

When patients enter a medical practice setting, they are often given a wrist band that is secured around their wrist. The band contains patient identification information such as name, date of birth, and so forth that links the patient with a computerized record of their health history. In present practice, the patient identification is printed on the wrist band in humanly sensible form and also printed as a QR code, i.e., a well-known 2-dimensional barcode. The QR code can be small and contain only a few pieces of information, or it can be larger and contain binary codes representative of thousands of alphanumeric characters.

A computerized database system, such as the EPIC computer program and system is used widely in hospitals today for storing and retrieving patient information. EPIC is a product of EPIC Systems Corporation, of Verona, WI, USA. EPIC's memory contains individual patient information. This information is accessed and modified through the use of computer interfaces such as computer terminals with keyboards and, in many cases, a barcode reader that is connected to a computer terminal in communication with the EPIC system.

Background—Prior Art—Patient Vital Signs Apparatus—Fig. 1

Many medical facilities use automated digital devices to read a patient's temperature, blood pressure, blood oxygen level, pulse rate, carbon dioxide level, mean arterial pressure, etc. Exemplary devices are the IntelliVue MX450 sold by Philips North America Corporation, of Andover, MA, U.S.A., the Huntleigh Smartsigns LitePlus Vital Signs monitor, sold by Huntleigh Healthcare Ltd., of Cardiff, Wales, U.K., and others. Some of these devices are portable, while others are wall-mounted. Many of these instruments contain transducers, electronic circuitry, software, firmware, and hardware for obtaining some or all of these measurements in a single housing. The housing has a plurality of individual readouts or a screen that convey the results of readings to an observer.

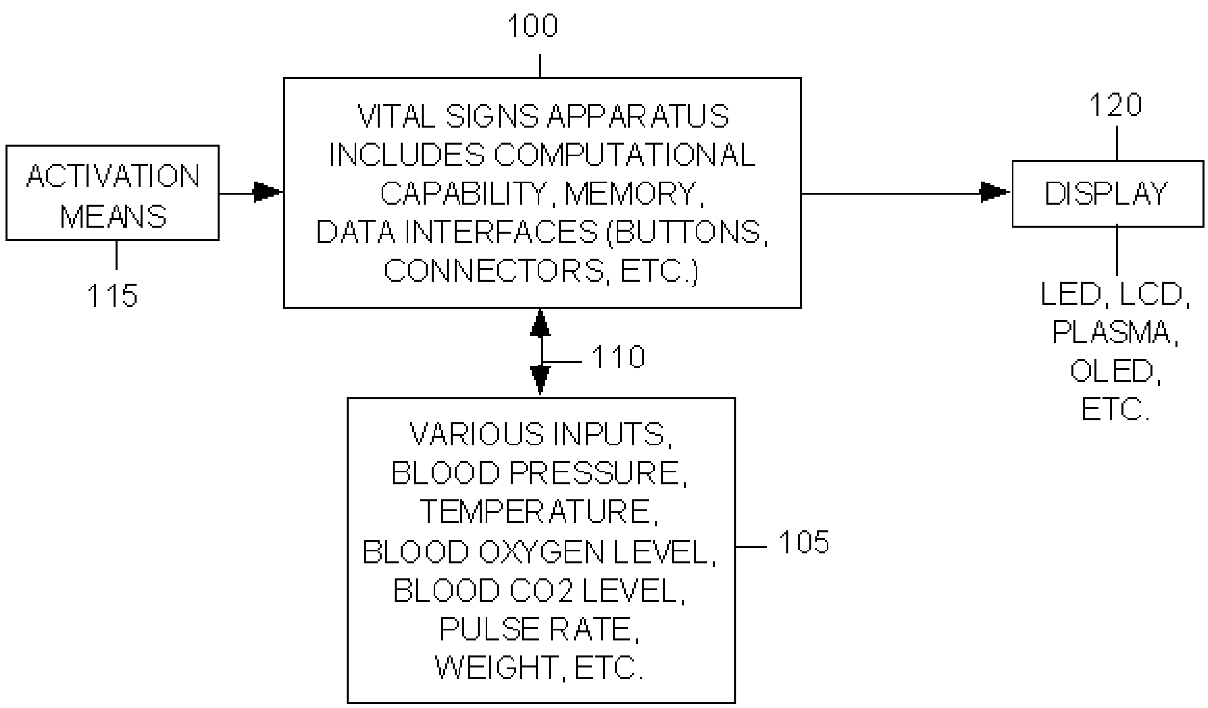

Fig. 1--Prior Art

Fig. 1 is a block diagram that shows a well-known prior-art vital signs measuring apparatus. The apparatus comprises a functional component 100 that includes computational capability, memory, data interfaces such as buttons, connectors, etc.

A plurality of inputs 105 includes transducers that measure blood pressure, temperature, blood oxygen level, blood CO2 level, pulse rate, weight, etc. Signals associated with each transducer are communicated to functional component 100 via a link 110.

Activation means 115 are provided to initiate one or more measurements. In use, a medical practitioner affixes a digital blood pressure cuff on a patient's arm, secures a digital pulse-oximeter to the patient's finger, places a digital thermometer in the patient's mouth, activates a transducer for each measurement, and waits for each measurement to complete.

A display 120 provides humanly sensible indicia of all measurements. When all measurements are complete, the medical practitioner reads indicia representative of the readings in a plurality of readouts such as LEDs, or on a screen, such as a liquid crystal display.

Background—Prior Art—Barcode Reader—Fig. 2

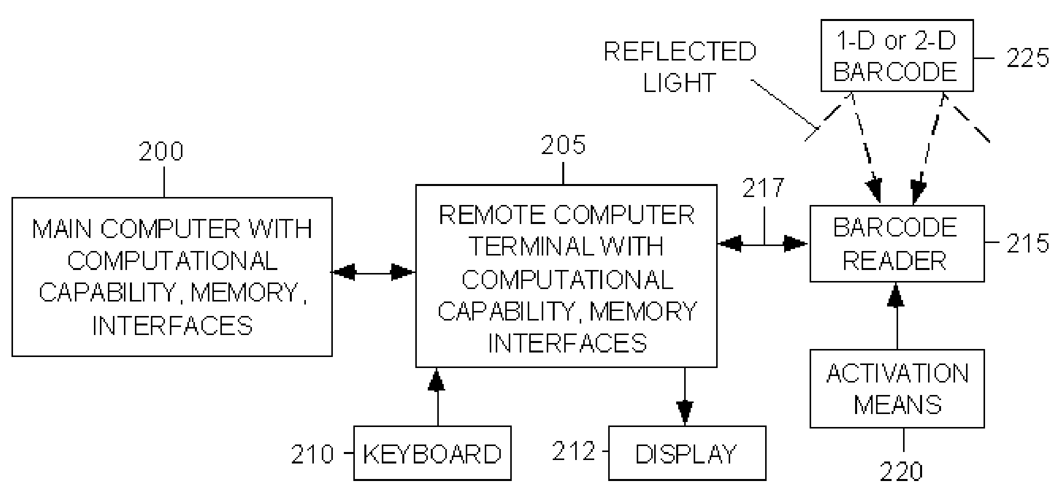

Fig. 2--Prior Art

Fig. 2 is a block diagram showing elements of a typical barcode reader. An exemplary system comprises a main computer 200, a remote computer terminal 205 with a keyboard 210, a display 212, and a barcode reader 215 with activation means 220, such as a button or touch control. Barcode reader 215 communicates with terminal 205 via an electronic link 217 such as fiber-optic, hard wire, radio link such as Bluetooth, etc. in well-known fashion. When reader 215 is activated by activation means 220, an optical sensor (not shown) within reader 215 receives a light image that is reflected from a previously printed barcode 225. Circuitry within barcode reader 215 is arranged to decode a received light image and deliver a stream of data to computer terminal 205 via electronic link 217.

Recording Vital Signs.

In the past, an operator would use a barcode reader to read a printed barcode such as barcode 225 on a patient's wrist band using reflected light that was supplied by ambient room light or a light source (not shown) within reader 215. That information would be decoded and delivered to computer 200, as described above.

When readings obtained from the vital signs apparatus in Fig. 1 were complete and displayed on display 120, an operator then manually operated computer keyboard 210 to enter the data for each reading into computer 205, which then communicates the data to an EPIC or other system 200 for a computerized record, i.e. the patient's "chart".

Other types of entry of patient data can be used. For example, Bluetooth radio transmission technology, fiber optics, and hard-wired connections can be used. Each of these has its own advantages and disadvantages. For example, hard-wired and fiber optic connections require the use of connector which is an inconvenience or even impractical in some situations, such as when a vital signs apparatus is portable. Bluetooth connections can suffer from interference and even disconnections.

While the readouts on display 120 that contain indicia of a patient's vital signs are presumed to be accurate, there is a possibility of error when the information is manually transcribed from a readout or display to the computerized record. This transcription also takes time.

Summary

I have discovered a way to communicate patient information from a vital signs apparatus to a computer terminal that overcomes deficiencies in the prior art. Recordation of data using my system is virtually instant and eliminates transcription errors. A vital signs apparatus contains circuitry that summarizes all patient data, date, time, blood pressure, temperature, blood oxygen level, and any other desired information and presents this information in the form of a dynamic, i.e., updatable, barcode that is displayed on the apparatus. The barcode display can be a 2-D barcode, such as a QR barcode, or a linear barcode. When all desired vital signs measurements are complete, a barcode appears on the readout of the vital signs apparatus. An operator then reads this barcode using a barcode reader that is included and operational in the computerized chart recording system. All the information in the barcode is immediately conveyed to the computerized charting system without manual transcription by an operator. Other information in addition to the patient's physiological data can include the serial number of the vital signs apparatus, time, date, hospital department, etc. In this way, a complete record is obtained quickly and without transcription errors.

First Embodiment—Description—Fig. 3

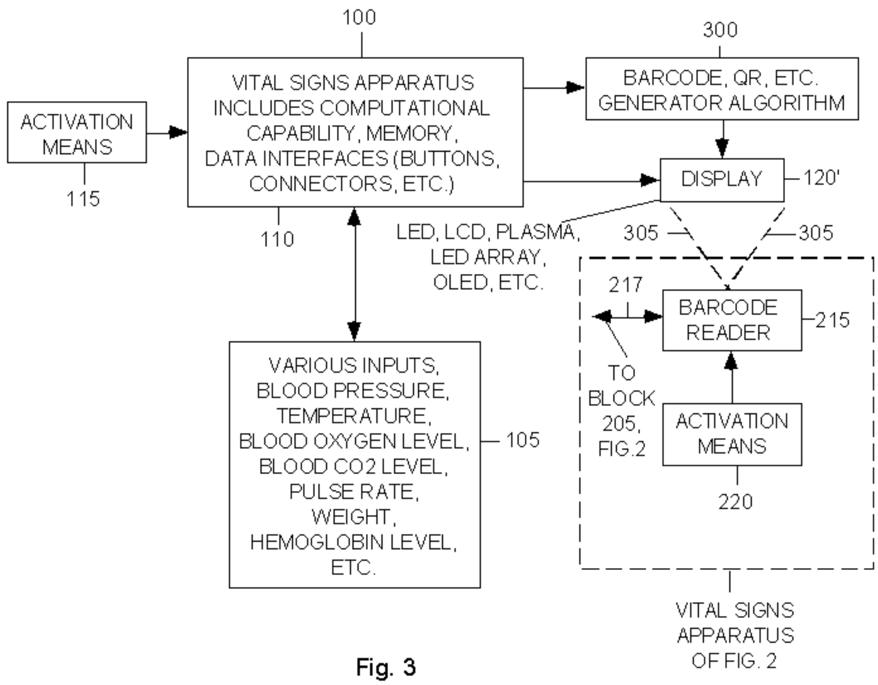

Fig. 3

Fig. 3 is a block diagram showing an embodiment according to one aspect. The apparatus in Fig. 3 is similar to that shown in Fig. 1, but with the addition of a barcode, QR, etc. generator 300 and a modified display 120′.

Barcode generator 300 uses well-known algorithms to generate barcodes of a predetermined kind (1-D, 2-D, QR, etc.), representative of data obtained by apparatus 100. I.e., when apparatus 100 is activated by activation means 115, apparatus 100 receives inputs from block 105. Inputs from block 105 are converted to humanly sensible indicia within apparatus 100 and displayed on display 120′. At the same time, apparatus 100 presents the same data to barcode generator 300 which generates barcode data for display on display 120′.

Display 120′ is an LED, OLED (organic light emitting diode), LCD, plasma, LED array, or other indicating means that displays both humanly sensible and barcode-reader-sensible information.

First Embodiment—Operation—Figs. 3 through 7

Fig. 3 shows one aspect of operation of an embodiment. When apparatus 100 presents barcode data on display 120′, a user of apparatus 205 scans barcode on display 120′ by activating activation means 220 while aiming reader 215 at the barcode data (not shown in this view) on display 120′, as indicated by scan lines 305.

Fig. 4

Fig. 4 is an example of a QR barcode 400. Barcode 400 contains the following information:

Vital Signs, Brand XYZ, Serial No. 14852235526, Weight 100 kg, BP 120/80, Pulse 80, Oxy 98, CheckSum C4MM2XP9.

Entries are comma-delimited and a period signals the end of the data string. Other data arrangements are possible. The first entry indicates that the following data are vital signs. The brand and serial number identify apparatus 100. The weight, BP (blood pressure), pulse rate, and oxygenation level are normally acquired during use of apparatus 100. A checksum is computed using a suitable algorithm and the checksum is added to the data by apparatus 100 and barcode generator 300. Checksums are well-known in data transmitting apparatus. They ensure integrity of data, i.e. that the data received are the same as those sent. When barcode reader 215 and block 205 receive the above data, they re-generate the checksum using the same algorithm. If the checksums are equal, data sent from display 120′ is presumed to be the same as data delivered to block 205 (Fig. 2) by reader 215.

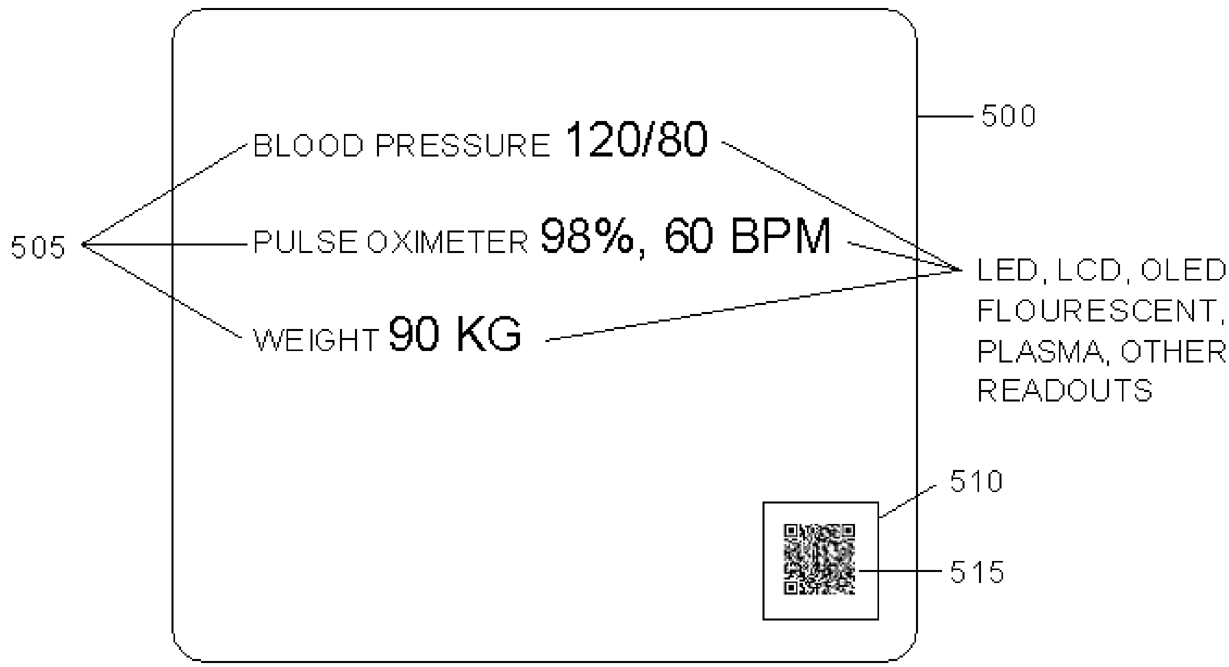

Fig. 5

Fig. 5 is a diagrammatic view of a readout panel 500 of a vital signs apparatus such as shown in Fig. 3. Panel 500 displays data using display components such as LED, LCD, fluorescent, plasma, and other readouts. A graphic display device 510, such as model DT024CTFT made by Displaytech USA, of Carlsbad, CA, U.S.A., is incorporated into panel 500. When vital signs measurements are complete, device 510 displays a barcode 515 representative of the acquired data for vital signs. If no data are present, barcode 515 is blank. Alternatively, barcode 515 is arranged to display the most recently available data. This is useful in cases where data are taken seriatim.

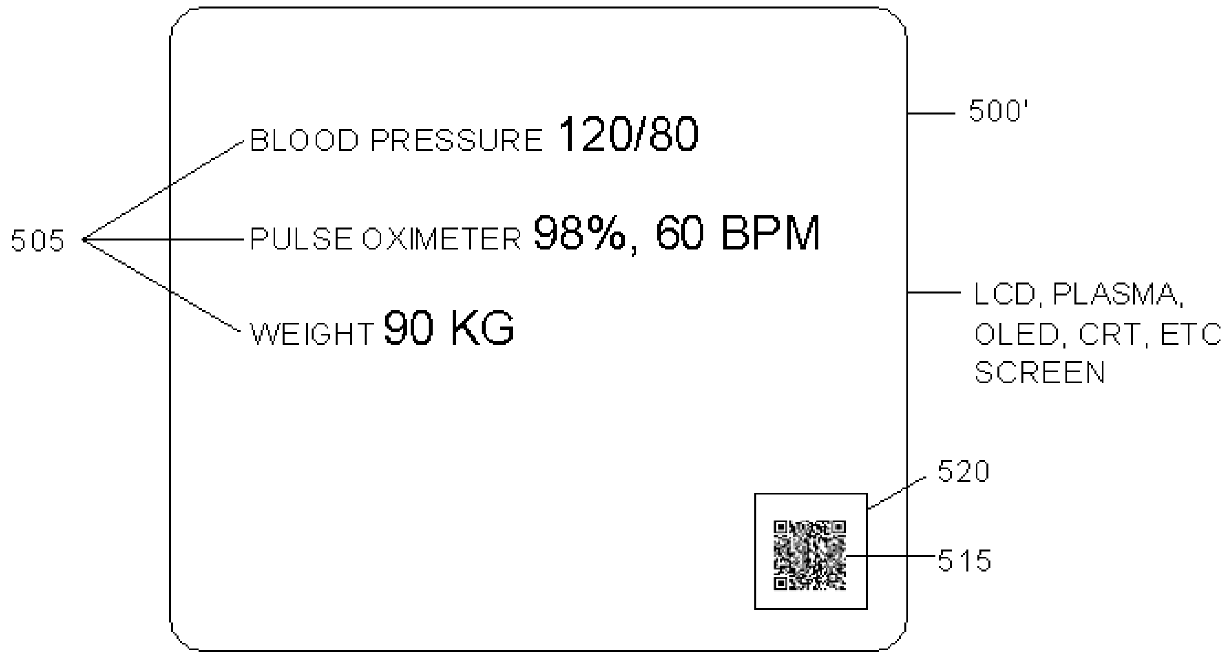

Fig. 6

Fig. 6 is a diagrammatic view of a readout screen 500′ such as an LCD (OLED, plasma, cathode-ray tube, etc.) monitor display. Some or all of characters 505 appear in screen 500′. When vital signs measurements are complete, barcode 515 is displayed and is ready for scanning by barcode reader 215 (Fig. 3). If desired, a graphic outline 520 indicates the location of barcode 515. If no data are present, barcode 515 is blank. As above, barcode 515 is alternatively arranged to display the most recently available data.

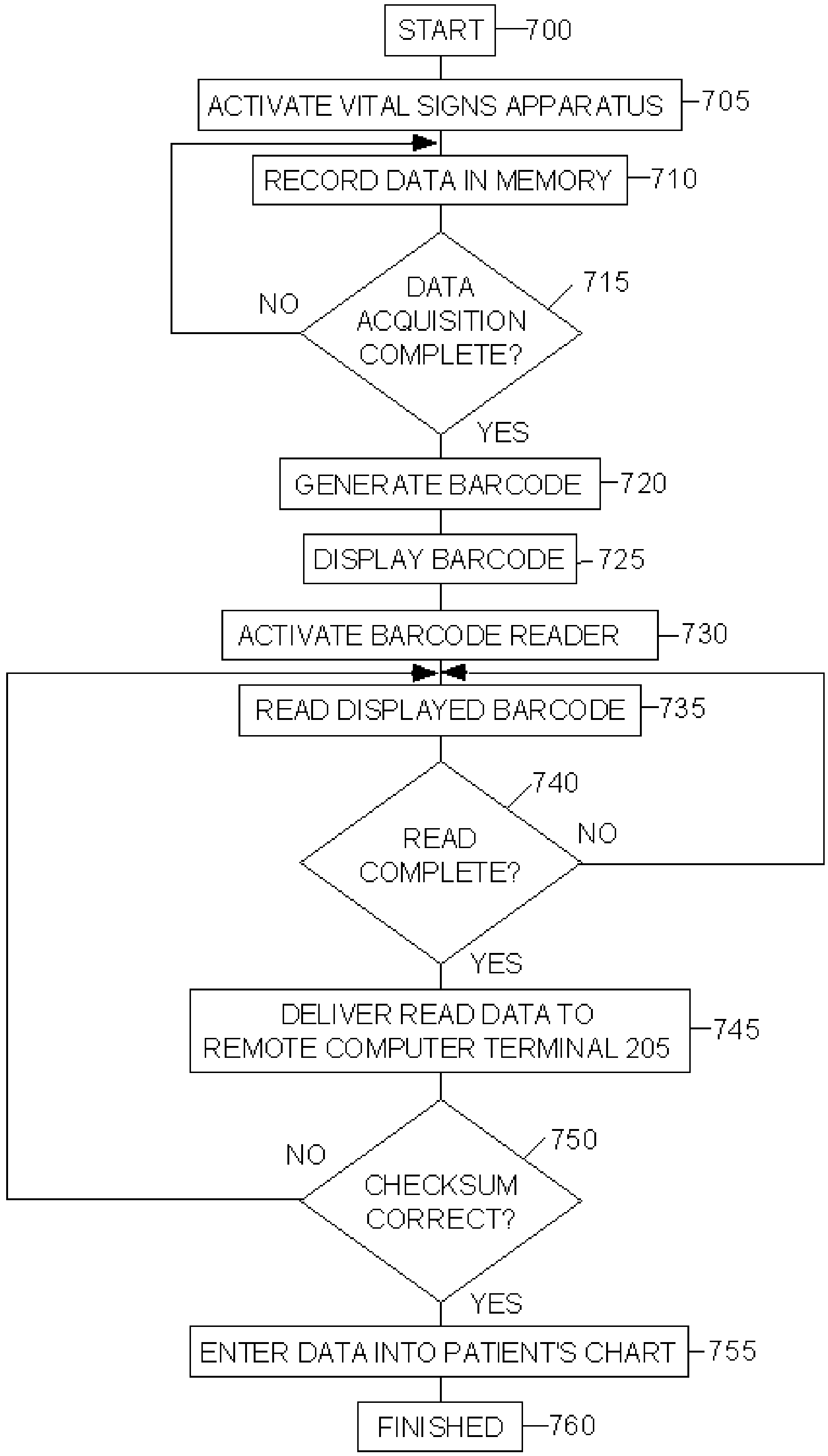
START
700
ACTIVATE VITAL SIGNS APPARATUS
705
RECORD DATA IN MEMORY
710
DATA ACQUISITION COMPLETE?
715
NO
YES
GENERATE BARCODE
720
DISPLAY BARCODE
725
ACTIVATE BARCODE READER
730
READ DISPLAYED BARCODE
735
READ COMPLETE?
740
NO
YES
DELIVER READ DATA TO REMOTE COMPUTER TERMINAL 205
745
CHECKSUM CORRECT?
750
NO
YES
ENTER DATA INTO PATIENT'S CHART
755
FINISHED
760

Fig. 7

Fig. 7 is a flow chart showing one aspect of operation of the present embodiment. At the start (block 700), an operator (not shown in this view) applies transducers to a patient. The operator then activates vital signs apparatus 100 (Fig. 3) by using activation means 115 (block 705). Data from various inputs 105 are recorded in the memory of apparatus 100 (block 710). If data acquisition is not complete, control returns to block 710. If data acquisition is complete, barcode generator 300 is activated and a barcode 400 (Fig. 4) is generated (block 720) and then displayed on display 515 (Figs. 5 and 6) (block 725).

Next, barcode reader 215 (Fig. 3) is activated and barcode 515 is read (block 735). If the reading of the present data is not complete, control returns to block 735. If the read is complete, the read data are delivered to terminal 205 (Fig. 2) (block 745). A checksum associated with the barcode data is checked (block 750) and if the checksum is incorrect, the barcode is re-read (block 735). If the checksum is correct, remote terminal 205 sends the data to main computer 200 for entry into the present patient's chart (block 755), and the process is finished (block 760).

Alternative Embodiments—Figs. 8 and 9

Fig. 8 shows a more generalized, alternative embodiment according to one aspect. In Fig. 8 a 2-D barcode 515 (or 515′) is generated using algorithms operational within a computer 800. Computer 800 has an optional keyboard 805 for manual entry of information. A link 810 connects computer 800 to a display screen 120. One or more 1-D or 2-D barcodes (515′, 515) that are representative of solutions computed within computer 800 are displayed on a screen 120. It is presumed that barcode 515 (515′) appears in its entirety, i.e. is not cropped by being located so that a portion lies outside the margins of screen 120. Display screen 120 ranges in size from 1 cm^2 to 1 m^2, although other sizes can be used. Display screen 120 can be self-illuminating, or illuminated by reflected light that is either ambient or applied by an external illuminating device (not shown) such as an LED.

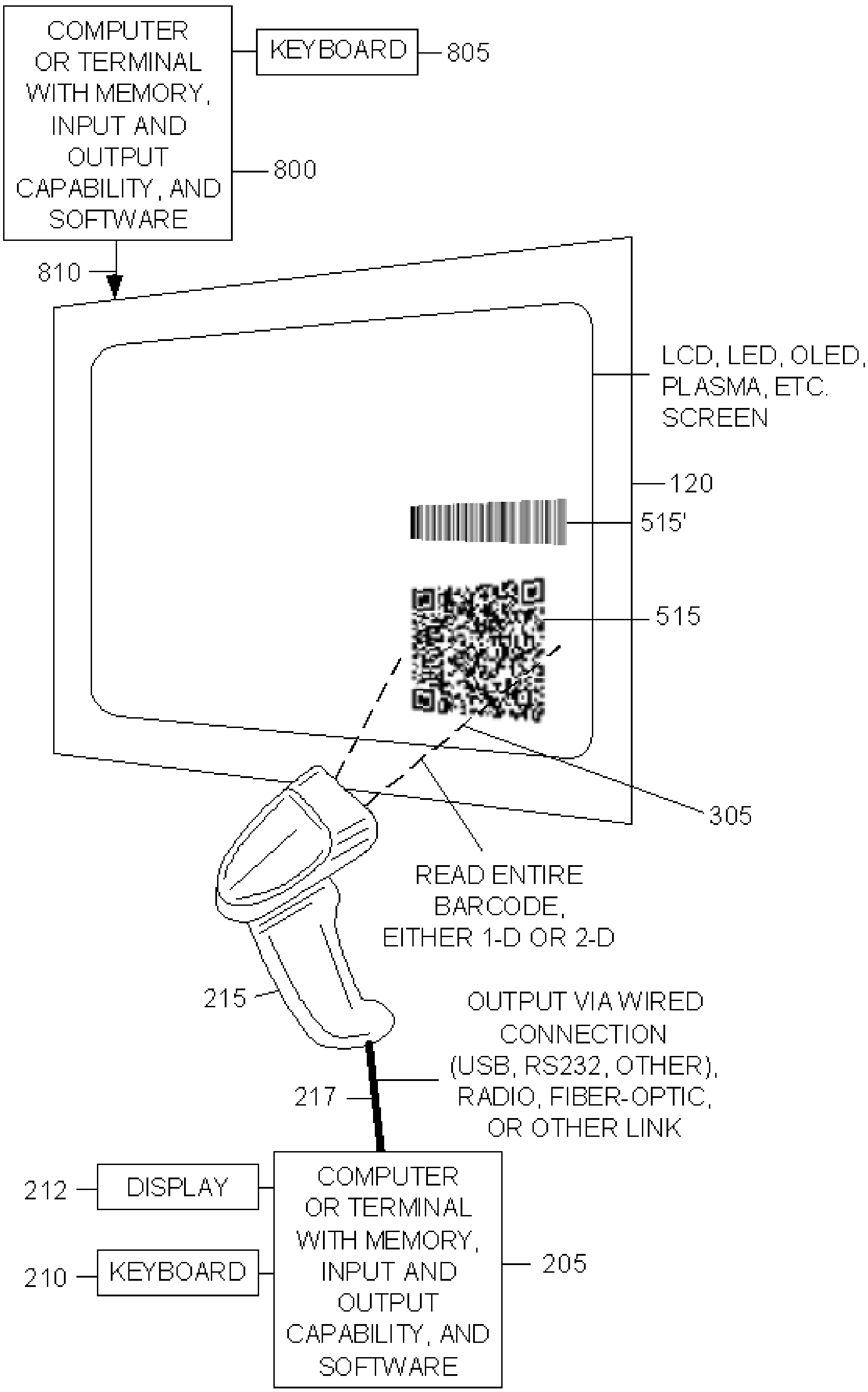
COMPUTER OR TERMINAL WITH MEMORY, INPUT AND OUTPUT CAPABILITY, AND SOFTWARE
KEYBOARD
805
800
810
LCD, LED, OLED, PLASMA, ETC. SCREEN
120
515'
515
305
READ ENTIRE BARCODE, EITHER 1-D OR 2-D
215
OUTPUT VIA WIRED CONNECTION (USB, RS232, OTHER), RADIO, FIBER-OPTIC, OR OTHER LINK
217
DISPLAY
212
KEYBOARD
210
COMPUTER OR TERMINAL WITH MEMORY, INPUT AND OUTPUT CAPABILITY, AND SOFTWARE
205

Fig. 8

A hand-held barcode reader 215 that is suitable for reading 1-D and 2-D barcodes is activated and positioned to read barcode 515 (515′) in its entirety. Alternatively, instead of being hand-held, barcode reader 215 is stationary and secured to a surface, if desired. Barcode reader 215 then decodes and transmits the contents of barcode 515 (or 515′) via a link 217 to a remote computer or computer terminal such as 205 for further use, as described above. The decoded contents are transmitted to computer or terminal 205 as a serial stream of alphanumeric characters. Computer terminal 205 also optionally includes a keyboard 210 and a display 212. Display 212 is arranged to display the decoded contents of barcode 515 (515′). As above, display 120 is an LCD, LED, OLED, plasma, or other humanly sensible display.

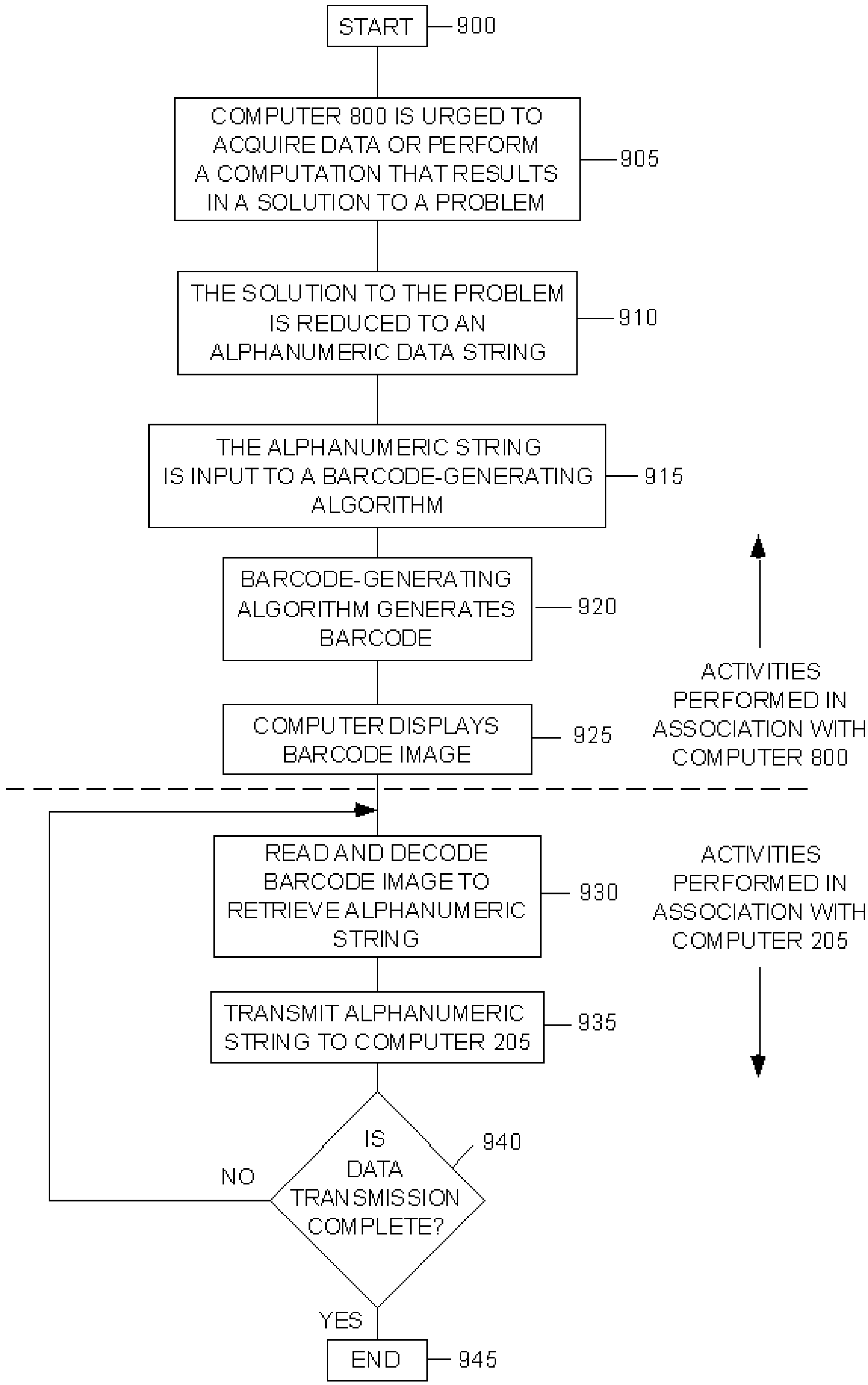
START
900
COMPUTER 800 IS URGED TO ACQUIRE DATA OR PERFORM A COMPUTATION THAT RESULTS IN A SOLUTION TO A PROBLEM
905
THE SOLUTION TO THE PROBLEM IS REDUCED TO AN ALPHANUMERIC DATA STRING
910
THE ALPHANUMERIC STRING IS INPUT TO A BARCODE-GENERATING ALGORITHM
915
BARCODE-GENERATING ALGORITHM GENERATES BARCODE
920
COMPUTER DISPLAYS BARCODE IMAGE
925
ACTIVITIES PERFORMED IN ASSOCIATION WITH COMPUTER 800
READ AND DECODE BARCODE IMAGE TO RETRIEVE ALPHANUMERIC STRING
930
ACTIVITIES PERFORMED IN ASSOCIATION WITH COMPUTER 205
TRANSMIT ALPHANUMERIC STRING TO COMPUTER 205
935
IS DATA TRANSMISSION COMPLETE?
940
NO
YES
END
945

Fig. 9

Fig. 9 is a flow chart showing operation of the system in Fig. 8. At the start (block 900), all electronic circuitry is energized and activated. Next, in response to a command from keyboard 805 (Fig. 8) or another source (not shown), software within computer 800 is urged to acquire data or perform a computation that results in a solution to a problem such as computing mean aarterial pressure, etc. (block 905). Next, computer 800 reduces the solution to an alphanumeric data string (block 910). Computer 800 then inputs the alphanumeric data string into a barcode-generating algorithm (block 915), whereupon the barcode-generating algorithm generates barcode 515 (515′) (block 920) and computer 800 displays barcode 515 (515′) on display screen 120 (block 925). Next, barcode reader 815 reads and decodes barcode 515 (515′) (block 930) and transmits the previously generated alphanumeric string to computer 205 (block 935) for further use. If data transmission from computer 800 is complete (block 940), the process is at an end (block 945). If there are more data, i.e., if computer 800 displays another barcode 515 (515′) on display 120, then control of the present process reverts to block 930 for a reading of new, updated alphanumeric data.

Comparison of Prior Art and Specification.

Prior Art. Many computer programs and algorithms for generating and displaying barcodes are in use today. To use these programs, a user enters an alphanumeric data string into a computer and algorithms operating within the computer produce a corresponding barcode. The barcode is then delivered to a printer or displayed on a screen where it is read by a barcode reader. This is a 4-step process. I.e., (1) an operator enters string data into a computer using a keyboard and (2) those data are *directly* converted to a barcode using a barcode generating algorithm. (3) The barcode is displayed on a display. (4) A barcode reader reads the barcode on the display and reproduces the data string. This is a *one-time* conversion of an alphanumeric data string into a barcode. I.e., reading and re-reading of the barcode produces identical results.

Specification. The operation of the embodiments in this specification is different from the prior art. In this specification, a computer performs computations or receives data that are then converted into a stand-alone solution by algorithms that *are not related to barcode generation*. This stand-alone solution comprises an independent solution to a problem. The stand-alone solution can be used as-is and it can also be represented by an alphanumeric data string. Only then is the resulting alphanumeric data string from the independent solution input to a barcode generating algorithm that generates a data-representative barcode. This is necessarily a 7-step process: (1) a computer performs computations or receives data wherein the results of the computation or reception of data comprise a solution to a problem, (2) the solution of the problem is reduced to an alphanumeric data string, (3) the alphanumeric data string is input into a barcode generating algorithm, (4) the barcode-generating algorithm generates a barcode representative of the alphanumeric data string, (5) the resulting barcode is displayed on a display screen, (6) a barcode reader reads the barcode and reproduces the alphanumeric data string, and (7) the barcode reader transmits the alphanumeric data string to a computer. The data are *updatable* as new computations are performed or new data are received by a computer, and a new barcode is generated with each update of the data. I.e., reading and re-reading of subsequent barcodes produces *changeable* results.

Conclusion, Ramifications, and Scope

In one aspect of an embodiment, a data transfer system conveys patient data from a plurality of transducers in a vital signs measuring system to a computer interface using barcodes. A barcode display is added to prior-art patient monitoring and vital signs apparatus and a prior-art barcode reader scans the barcode display, finally transmitting the patient data to a computer terminal or a main computer or both. These data are entered into a patient's chart to form a permanent record. A patient's vital signs are communicated to a computer without requiring the use of a keyboard for manual transcription. This prevents errors in data entry and shortens the time required to deliver the data to a patient's permanent record. A digital readout is added to vital signs apparatus and displays a barcode representative of a patient's vital signs. Some computerized data systems such as EPIC already incorporate the use of barcodes to scan patient ID bracelets, medication labels, and the like. An addition of software and a display to a vital signs apparatus and addition of barcode scanning software feature to a computer terminal are all that is required to speed up patient vital signs recordation and to prevent transcription errors due to manual entry of patient data.

Although a QR barcode is described herein, another type of barcode such as a linear barcode can be used. A QR barcode comprises a very compact image, while a 1-dimensional barcode takes more space. Other 2-D barcodes can be used and have the same advantage as QR codes.

In other aspects of alternative embodiments, my discovery is equally applicable to other data-logging and data presentation applications, not necessarily related to vital signs monitoring. These include, but are not limited to, computer games, manufacturing process monitoring, etc.

The teachings above have presumed that the QR or other barcode is generated internally to the data acquisition and display apparatus. On the other hand, some data acquisition and display apparatuses have a hard-wired, radio link such as Bluetooth, or an Ethernet connection to an external computer terminal. A stand-alone barcode generator such as 300 (Fig. 3) can be interfaced to one of these connections so that the barcode generator receives patient monitoring information or other data, and then displays this information for subsequent reading by a barcode reader such as 215 (Fig. 3).