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(54) SYSTEMS AND METHODS FOR DATA VISUALIZATION

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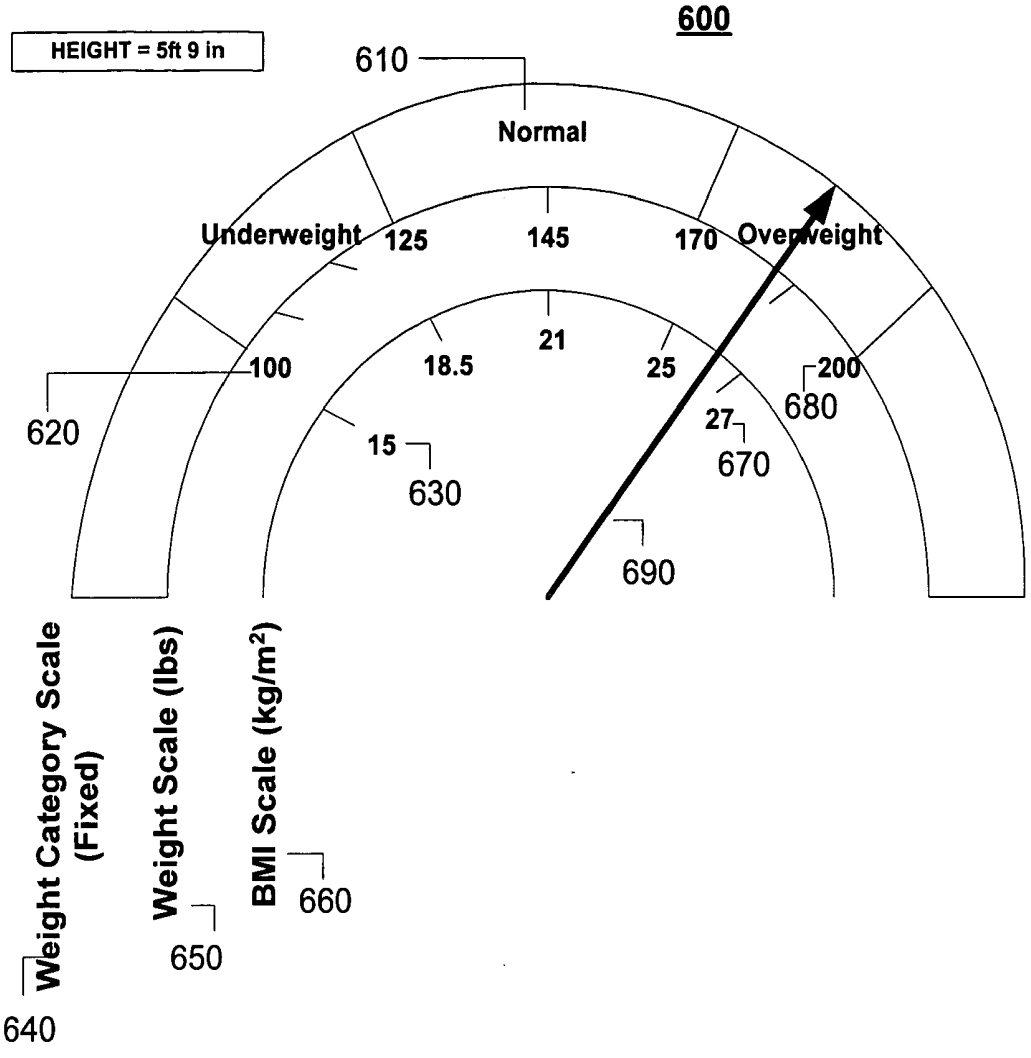
(57) **ABSTRACT**

Systems and methods consistent with embodiments of the present invention provide for a method for display of anthropometric measures on a plurality of scales, in an analog format, using a single pointer. In some embodiments, the plurality of data selected for display may comprise both raw and derived anthropometric data. In some embodiments, the raw data displayed may comprise the weight of a subject and the derived data displayed may comprise the BMI and the weight category of the subject. In some embodiments consistent with the present invention, the pointer may be aligned to a fixed scale corresponding to an anthropometric measure and other scales may be aligned with the pointer to correspond to the anthropometric measures represented by the individual scales. In some embodiments, some or all of the scales may be color-coded.



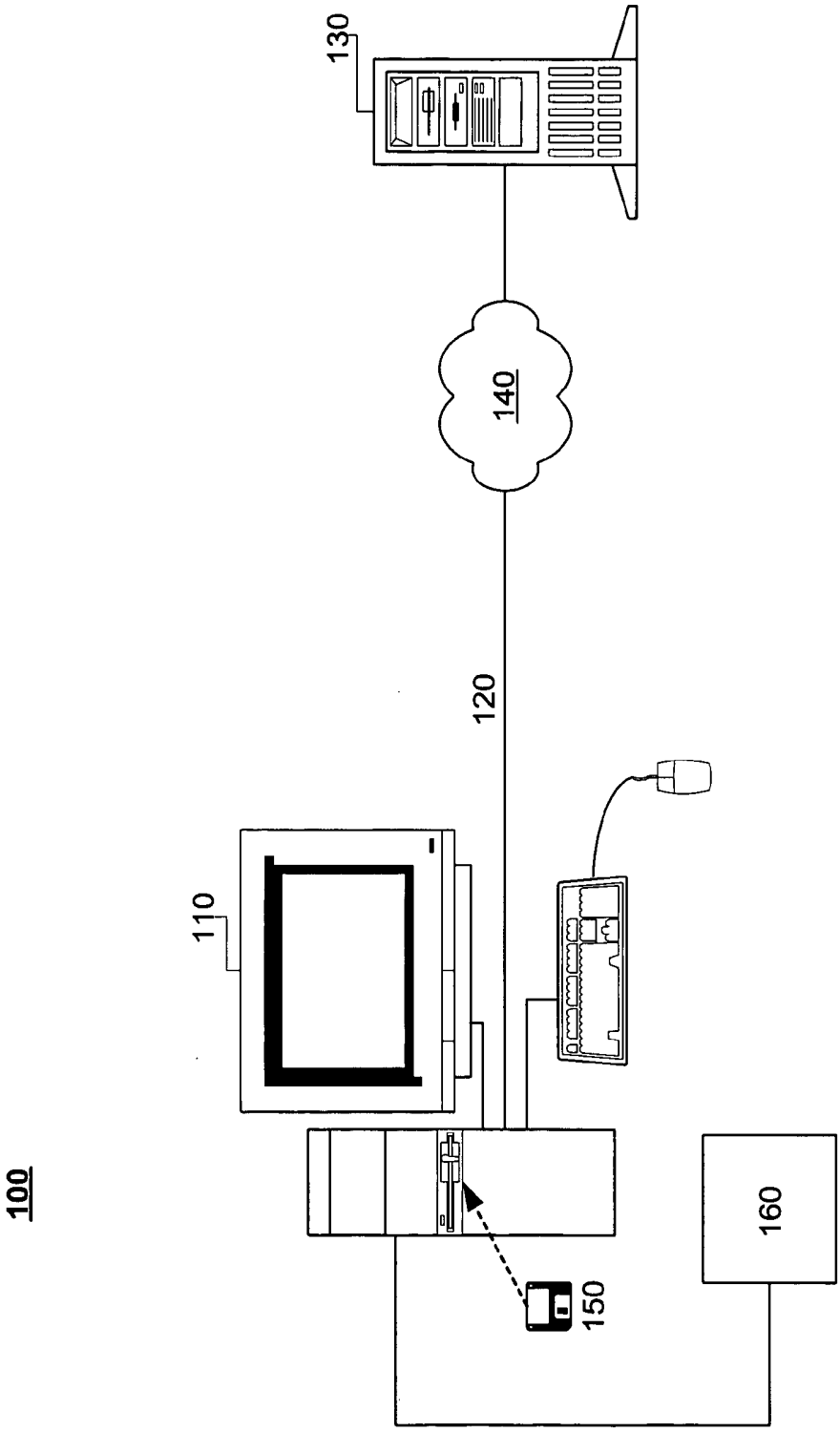


FIG. 1

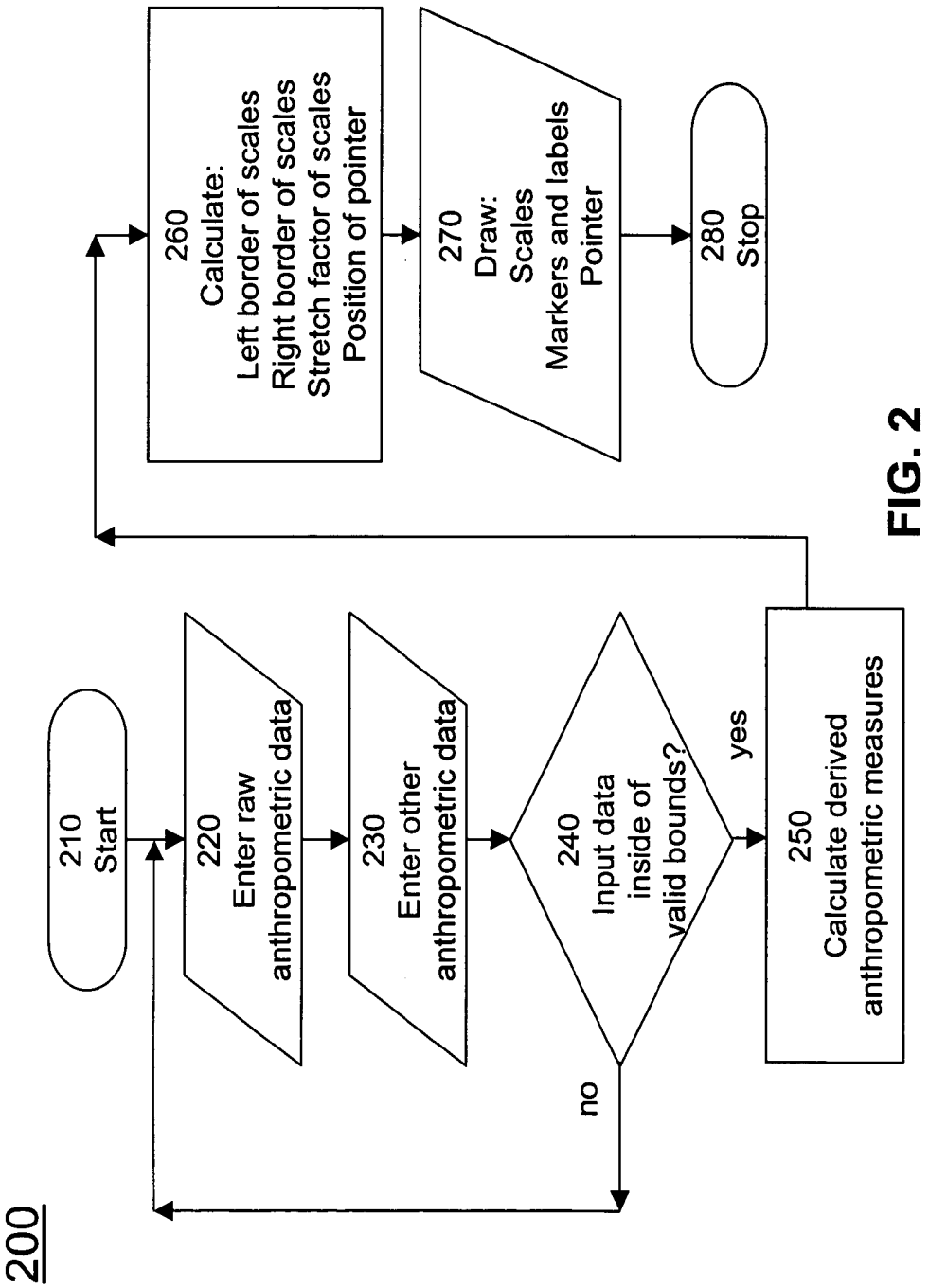

200
210
Start
220
Enter raw
anthropometric data
230
Enter other
anthropometric data
240
Input data
inside of
valid bounds?
no
yes
250
Calculate derived
anthropometric measures
260
Calculate:
Left border of scales
Right border of scales
Stretch factor of scales
Position of pointer
270
Draw:
Scales
Markers and labels
Pointer
280
Stop

FIG. 2

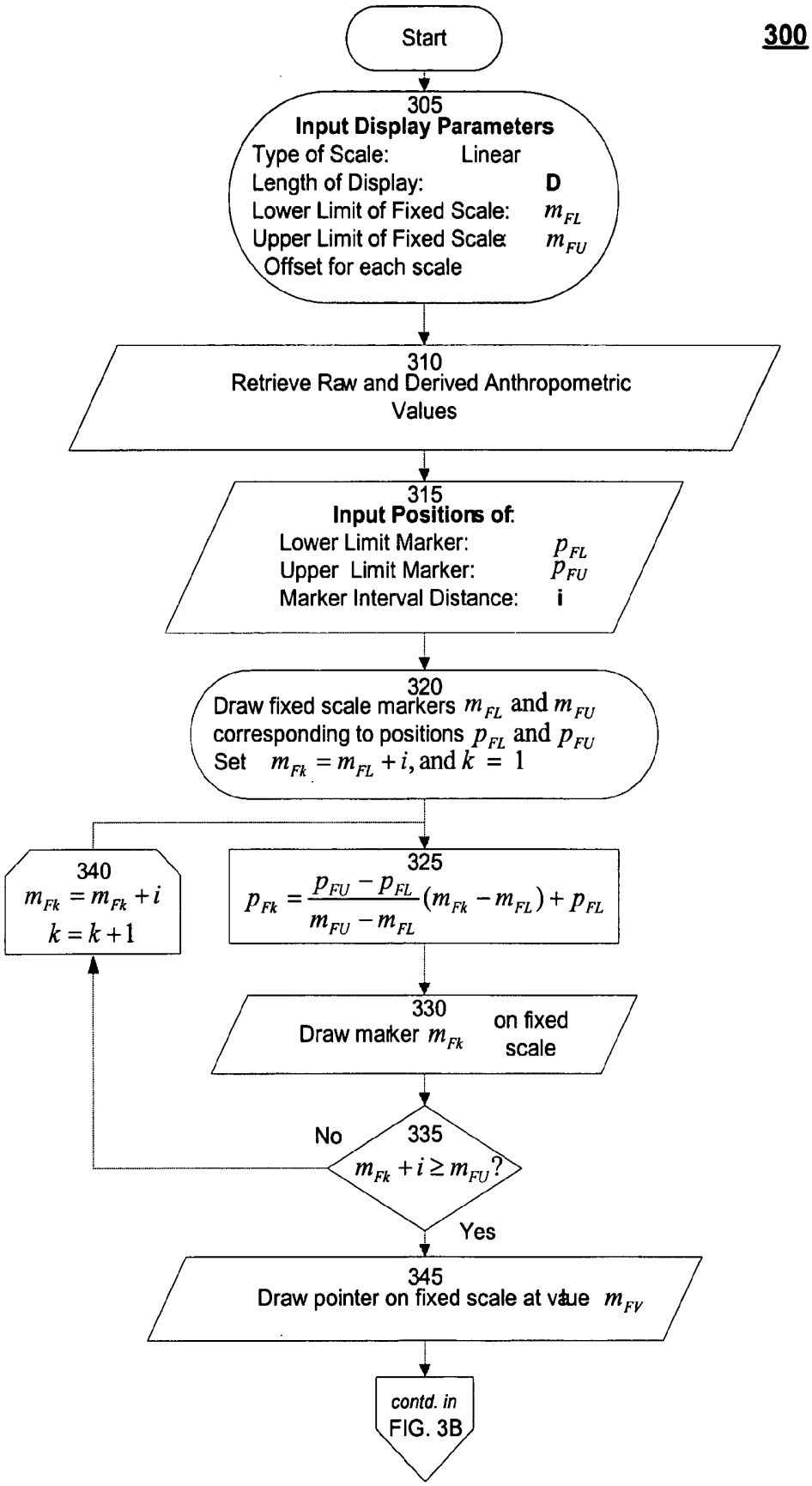

300
Start
305
Input Display Parameters
Type of Scale: Linear
Length of Display: D
Lower Limit of Fixed Scale: m_{FL}
Upper Limit of Fixed Scale: m_{FU}
Offset for each scale
310
Retrieve Raw and Derived Anthropometric Values
315
Input Positions of:
Lower Limit Marker: p_{FL}
Upper Limit Marker: p_{FU}
Marker Interval Distance: i
320
Draw fixed scale markers m_{FL} and m_{FU} corresponding to positions p_{FL} and p_{FU}
Set $m_{Fk} = m_{FL} + i$, and $k = 1$
340
$m_{Fk} = m_{Fk} + i$
$k = k + 1$
325
$p_{Fk} = \frac{p_{FU} - p_{FL}}{m_{FU} - m_{FL}}(m_{Fk} - m_{FL}) + p_{FL}$
330
Draw marker m_{Fk} on fixed scale
No
335
$m_{Fk} + i \geq m_{FU}$?
Yes
345
Draw pointer on fixed scale at value m_{FV}
contd. in FIG. 3B

FIG. 3A

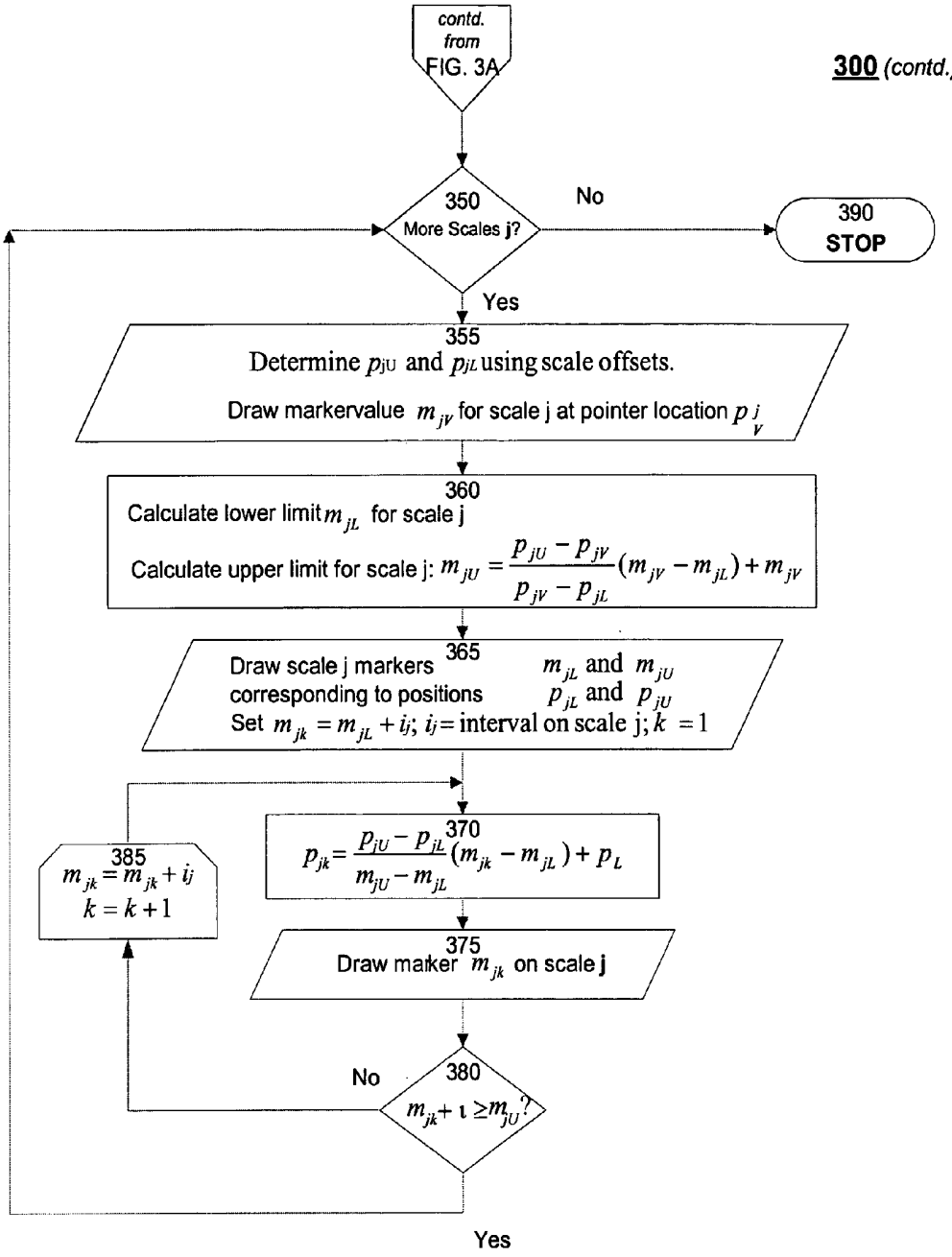

contd. from FIG. 3A
300 (contd.)
350
More Scales j?
No
390
STOP
Yes
355
Determine p_{jU} and p_{jL} using scale offsets.
Draw markervalue m_{jV} for scale j at pointer location p_{jV}
360
Calculate lower limit m_{jL} for scale j
Calculate upper limit for scale j: $m_{jU} = \frac{p_{jU} - p_{jV}}{p_{jV} - p_{jL}}(m_{jV} - m_{jL}) + m_{jV}$
365
Draw scale j markers m_{jL} and m_{jU}
corresponding to positions p_{jL} and p_{jU}
Set $m_{jk} = m_{jL} + ij$; ij = interval on scale j; $k = 1$
370
$p_{jk} = \frac{p_{jU} - p_{jL}}{m_{jU} - m_{jL}}(m_{jk} - m_{jL}) + p_L$
375
Draw marker m_{jk} on scale j
380
$m_{jk} + \iota \geq m_{jU}$?
No
385
$m_{jk} = m_{jk} + ij$
$k = k + 1$
Yes

FIG. 3B

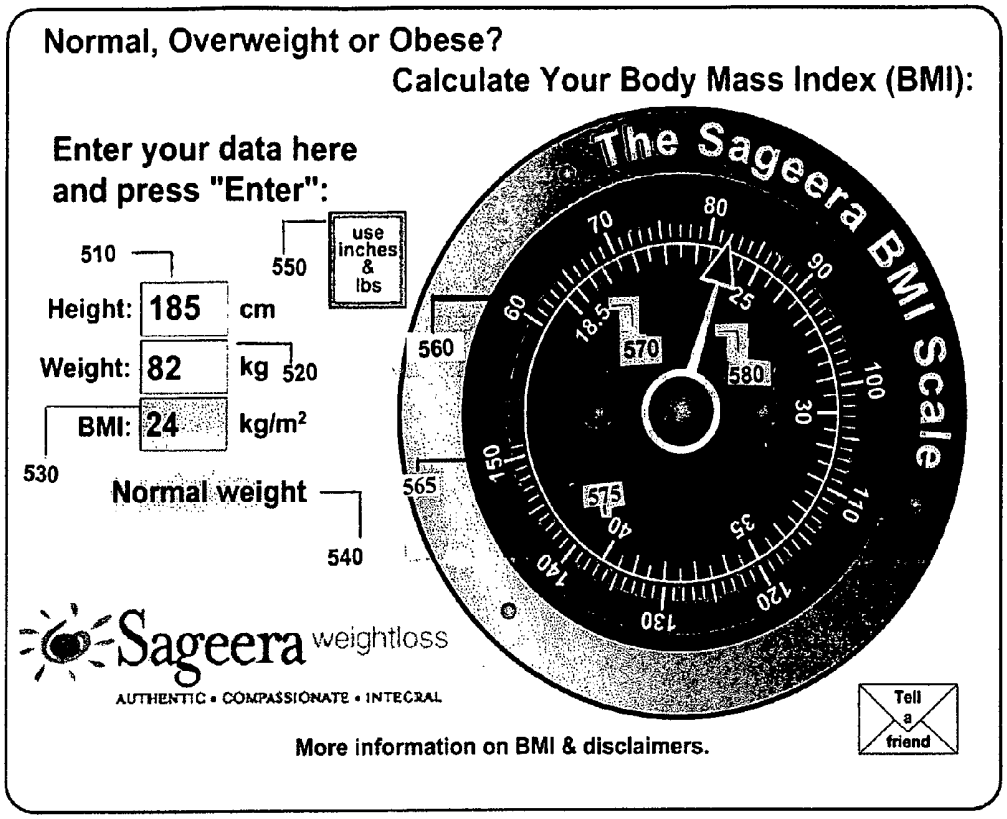

Normal, Overweight or Obese?
Calculate Your Body Mass Index (BMI):
Enter your data here and press "Enter":
510
550
use inches & lbs
Height: 185 cm
Weight: 82 kg
520
BMI: 24 kg/m²
530
Normal weight
540
The Sageera BMI Scale
560
565
570
575
580
Sageera weightloss
AUTHENTIC • COMPASSIONATE • INTEGRAL
More information on BMI & disclaimers.
Tell a friend
500

FIG. 4

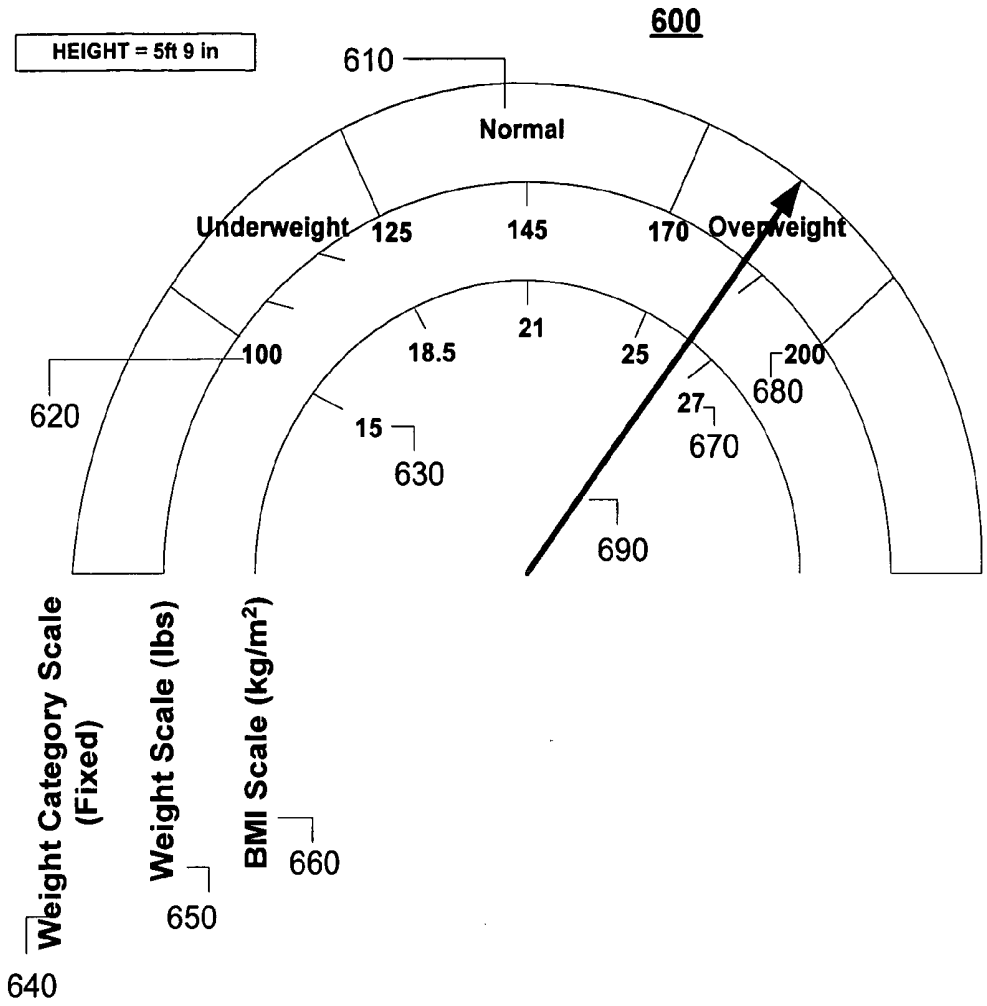

600
HEIGHT = 5ft 9 in
610
Normal
Underweight
125
145
170
Overweight
100
18.5
21
25
200
620
15
630
27
680
670
690
Weight Category Scale (Fixed)
Weight Scale (lbs)
BMI Scale (kg/m²)
660
650
640

FIG. 5

SYSTEMS AND METHODS FOR DATA VISUALIZATION

BACKGROUND

[0001] 1. Field of the Invention

[0002] The present invention relates to the field of data visualization and in particular, to systems and methods for the display of anthropometric data.

[0003] 2. Description of Related Art

[0004] Anthropometric data, including both raw and derived data, is increasingly used by health care professionals and patients to help monitor, track and achieve health and wellness goals. Raw anthropometric data pertaining to a subject can be directly measured using a measuring device. Derived anthropometric measurements can be obtained by combining raw anthropometric measurements with each other, or with other data pertaining to a subject such as gender, race, or ethnicity.

[0005] For example, a derived anthropometric measure termed the Body Mass Index ("BMI") is often used to calculate a subject's weight category. Knowledge of a subject's weight category is important in the diagnosis of obesity and associated health risks, such as diabetes and coronary heart disease. To calculate BMI using current standardized formulas, a patient's height and weight are measured, and BMI is then calculated as:

$$BMI = \frac{\text{Weight}}{Height^2}$$

[0006] Thus, health care professionals and patients may derive a weight category for a subject by 1) taking raw measurements of height and weight, 2) deriving a Body Mass Index ("BMI") for the subject based on the mathematical formula above, and then **3)** correlating the BMI with a weight category using a table, such as Table 1 below. The measured height and weight would constitute raw anthropometric data while the BMI and weight category for the subject would constitute derived anthropometric data.

TABLE 1

BMI in kg/m^2	Weight Category
BMI < 18.5	Underweight
18.5 ≦ BMI < 25	Normal weight
25 ≦ BMI < 30	Overweight
30 ≦ BMI < 35	Obesity class I
35 ≦ BMI < 40	Obesity class II
BMI ≧ 40	Obesity class III ("morbid obesity")

[0007] In some instances, height and weight information pertaining to a subject could be entered into a software program that would then compute the BMI and associated weight category of the subject. Selected measurements chosen from the entered measurements are then presented to the user. Presentation of the measurements often takes the form of separate displays of the calculated BMI and/or weight category. These displays are effected by a simple textual presentation of the selected anthropometric data, and occasionally by separate scales for each selected metric that is sought to be displayed.

[0008] Although BMI has been prevalent in the medical community, laypeople have trouble understanding and getting used to this relatively new metric. Not only is it impractical to calculate the mathematical formula for BMI mentally, but subjects must also contend with the translation of their weight and height measurements to and from the metric system. Patients, as well as health care professionals, therefore must rely on tables, or calculators, to determine BMI.

[0009] The use of tables and calculators may simplify the mechanics of the calculation process, but they fail to provide a solution to the real issues facing patients. For example, a BMI of 25 kg/m^2 is just at the border between "normal" and "overweight," according to the table above. A BMI of 30 kg/m^2 is at the border between "overweight" and "obese." Patients in these situations are more interested in knowing the degree to which they exceed a weight norm or the amount of weight that they must lose in order to fall into a lower weight category. The BMI measure does not directly provide this information. In fact, while presently existing BMI calculators may provide the BMI and a weight category pertaining to a subject, there is no tool that outputs both the BMI and weight in an easy-to-understand, familiar, intuitive, and quantitative display.

[0010] Similarly, absolute maximal oxygen consumption ("$VO2_{Max}$") is often used as a measure of a subject's physical fitness. Absolute maximal oxygen consumption represents the milliliters of oxygen that a person consumes when performing a standard physical activity, such as running on a treadmill, or using an exercise bike. Maximal oxygen consumption may be measured directly using an airflow measuring apparatus connected to the exercise machine or indirectly by measuring the subject's heart rate variability. Relative maximal oxygen consumption ("Rel. $VO2_{Max}$") is obtained by dividing $VO2_{Max}$ by a person's weight in kilograms. Medical literature uses Rel. $VO2_{Max}$ in conjunction with a person's gender and age to arrive at a fitness category for the person, which ranges from "very poor" to "average" to "excellent". A subject receiving this information, however, has no way of correlating his weight, which is controllable, with the fitness category measure. In other words, the subject may not be able to see how changes in weight will affect the subject's fitness category.

[0011] In general, this problem arises whenever a derived anthropometric measure such as BMI, or Rel. $VO2_{Max}$ is used as a means to quantitatively express a particular characteristic, such as a weight category. This is because the subject only has control of the physical quantity (such as the weight) associated with the raw metric underlying the derived anthropometric measure (such as BMI, or Rel. $VO2_{Max}$). Therefore, subjects have an immediate interest in establishing a correlation between the controllable physical quantity that underlies the derived metric and the derived metric itself.

[0012] A display mechanism that allows subjects to intuitively and visually correlate a derived anthropometric measure with its underlying controllable raw anthropometric measure, would empower recipients of the information by giving them a practical means of tracking, monitoring and reaching health and wellness goals.

SUMMARY

[0013] In accordance with the present invention, systems and methods for the display of anthropometric information are presented.

[0014] In some methods for the display of anthropometric information, raw anthropometric data pertaining to a subject is accepted and derived anthropometric measures based on the raw anthropometric data are calculated. A plurality of anthropometric data is then selected for display and the selected anthropometric data is displayed on a plurality of scales in an analog format using a single pointer. In some embodiments consistent with the present invention, the plurality of data selected for display may comprise of both raw and derived anthropometric data. In some embodiments consistent with the present invention, the raw data displayed may comprise the weight of a subject and the derived data displayed may comprise the BMI and the weight category of the subject. In some embodiments consistent with the present invention, the pointer may be aligned to a fixed scale corresponding to an anthropometric measure and other scales may be aligned with the pointer to correspond to the anthropometric measures represented by the individual scales. In some embodiments consistent with the present invention, some or all of the scales may be color-coded. These and other embodiments are further explained below with respect to the following figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] **FIG. 1** shows a block diagram of an anthropometric data visualization system consistent with some embodiments of the invention.

[0016] **FIG. 2** illustrates a flowchart describing steps in a method for the display of a plurality of anthropometric data according to some embodiments of the invention.

[0017] **FIG. 3A** and **FIG. 3B** show a flowchart describing an exemplary system for the display of raw and derived anthropometric data of a subject according to some embodiments of the invention.

[0018] **FIG. 4** shows a display screen for an exemplary circular scale, generated by a program that calculates and displays weight and BMI for a subject using a single pointer according to embodiments of the invention.

[0019] **FIG. 5** shows an exemplary radial scale that displays weight, weight category, and BMI for a subject using a single pointer according to some embodiments of the invention.

DETAILED DESCRIPTION

[0020] In some methods for anthropometric data visualization in accordance with the present invention, raw anthropometric data pertaining to a subject is accepted and/or measured. Derived anthropometric data is calculated based in part on the raw anthropometric data. In some embodiments consistent with the present invention, a plurality of the anthropometric data is then selected for display and the selected anthropometric data is displayed on a plurality of scales in an analog format using a single pointer.

[0021] **FIG. 1** illustrates an exemplary system **100** capable of displaying a plurality of anthropometric data according to the embodiments of the present invention. A computer software application consistent with the present invention may be deployed on a network of computers, as shown in **FIG. 1**, that are connected through communication links that allow information to be exchanged using conventional communication protocols and/or data port interfaces.

[0022] As shown in **FIG. 1**, exemplary system **100** includes a computing device **110** and a server **130**. Further, computing device **110** and server **130** may communicate over a connection **120**, which may pass through network **140**, which in one case could be the Internet. Computing device **110** may be a computer workstation, desktop computer, laptop computer, personal data assistants, handheld computers, mobile phones with computing capabilities, or any other computing device capable of being used in a networked environment. Server **130** may be a platform capable of connecting to computing device **110** and other devices too (not shown).

[0023] Connection **120** couples computing device **110** and server **130**, and may be implemented as a wired or wireless connection using conventional communication protocols and/or data port interfaces. In general, connection **120** can be any communication channel that allows transmission of data between computing device **110** and server **130**, including network channels and transfer of data between machines on fixed storage media. In one embodiment, for example, both computing device **110** and server **130** may be provided with conventional data ports, such as ADB, USB, SCSI, FIREWIRE, AAUI, and/or BNC ports for transmission of data through the appropriate connection **120**. In some embodiments, connection **120** may be a low-bandwidth connection, for example, a Digital Subscriber Line (DSL), an Asymmetric Digital Subscriber Line (ADSL), or a cable connection. The communication links could be wireless links or wired links or any combination consistent with embodiments of the present invention, that allows communication between computing device **110** and server **130**.

[0024] Network **140** could include a Local Area Network (LAN), a Wide Area Network (WAN), the Internet, cellular phone networks, and/or cellular data networks. In some embodiments consistent with the present invention, information sent over network **140** may be encrypted to ensure the security of the data being transmitted.

[0025] Computing device **110** also contains removable media drive **150**. Removable media drive **150** may include, for example, 3.5 inch floppy drives, CD-ROM drives, DVD ROM drives, CD±RW or DVD±RW drives, USB flash drives, and/or any other removable media drives consistent with embodiments of the present invention. In some embodiments consistent with the present invention, portions of the software application may reside on removable media and be executed by computing device **110** using removable media drive **150**.

[0026] In some embodiments consistent with the present invention, System **100** may also contain a measuring device **160**. Measuring device **160** may be used for the measurement of raw anthropometric data pertaining to a subject. Raw anthropometric data could include directly measurable physical quantities such as weight, or height, or maximal oxygen consumption. As shown in **FIG. 1**, measuring device **160** may be connected to computing device **110**, through connection **120-2**. In some embodiments consistent with the present invention, System **100** may contain multiple

instances of measuring device **160**. Each such measuring device could be used to make raw anthropometric measurements pertaining to different health or biological parameters for a subject. In some embodiments consistent with the present invention, raw anthropometric data could be directly entered into computing device **110** by an operator using an input device.

[**0027**] A computer software application consistent with the present invention may be deployed on any of the exemplary computers, as shown in **FIG. 1**. For example, computing device **110** could execute software that may be downloaded directly from server **130**. In some embodiments consistent with the present invention, the software application for anthropometric data visualization may be distributed between the various computing systems shown in **FIG. 1**.

[**0028**] **FIG. 2** illustrates a flowchart **200** describing steps in a method for the display of a plurality of anthropometric data according to some embodiments of the invention. A software application to perform steps in a method for the display of a plurality of anthropometric data is started in step **210**, and raw anthropometric data is entered in step **220**. Raw anthropometric data could include directly measurable physical quantities such as weight, or height, or maximal oxygen consumption. In some embodiments consistent with the present invention, portions of the software application may reside on computing device **110**, server **130** or on removable media. In some embodiments consistent with the present invention, raw anthropometric data may be input directly from a measuring device and/or from other hardware or software components and/or manually entered by an operator. In some embodiments consistent with the present invention, data may be input from measuring devices such as exemplary measuring device **160**. In step **230**, other anthropometric data is input. Other anthropometric data could include data about sex, ethnicity, age, etc. that could be relevant in the calculation or categorization of derived anthropometric measures. For example, determining whether a certain anthropometric measure such as body fat percentage falls within a specific category such as normal, excessive etc. may depend on whether the subject is male or female. Other anthropometric data could be input by an operator and/or read from a file or from memory and/or input from another program. In step **240**, input data is checked for consistency. While the algorithm is capable of displaying a plurality of scales without limitation, in practice, the range of values may be limited to correspond to realistic expectations. For example, it would be unrealistic to expect a person 2 feet tall weighing 800 pounds, or one 12 feet tall weighing 80 pounds. Accordingly, in some embodiments, the input ranges for anthropometric data may be reasonably limited based on expected ranges of input data. If input anthropometric data contains an error or is outside allowed ranges, the program returns to step **220**, where the incorrect data may be re-entered. In step **250**, if the data is correct, derived anthropometric measures are calculated. In step **260**, display parameters are calculated for the plurality of data selected for display. In some embodiments consistent with the present invention, one of the scales may be fixed and the pointer set to point at the relevant value on the fixed scale. For each of the other scales, display parameters including limits for the scales and markings on the scales must be calculated based on the position of the pointer on that scale. For example, since the pointer position on a non-fixed scale represents the measured anthropometric value on that scale, the limits and markings on that scale must be calculated using the position of the pointer and the scale value at that position as a starting point. In some embodiments, mathematical relationships between the anthropometric measures may be exploited to quickly derive limits and markings for non-fixed scales. On a scale showing BMI, Weight and Weight category, for example, the ratio between BMI and Weight in kilograms (W) is constant for an adult subject and equal to the square of the adult subject's height (H) in meters. Therefore, if the BMI scale limits are used to derive the upper and lower limits of the weight scale then the distance between unit markings on the weight scale will need to be more tightly spaced than corresponding markings on the BMI scale by a factor of exactly (height)^2, in order for the pointer to line up at exactly the correct weight.

[**0029**] As an example:

if

$18 \leq BMI \leq 40$ on the BMI scale and H=2 meters, then

$(18*H^2) \leq W \leq (40*H^2)$ or $(18*4)\text{kg} \leq W \leq (40*4)\text{kg}$.

Therefore,

$18 \leq BMI \leq 40$ corresponds to $72 \leq W \leq 160$, on the W scale.

[**0030**] Thus, for the example above, if the W scale is drawn over the same length as the BMI scale with limits from 72 to 160 kilograms, and the distance separating 1 kilogram markings on the W scale is a quarter of the distance between 1 unit markings on the BMI scale, then the pointer will automatically point to the correct weight when drawn to point to the BMI measure. For example, if the BMI and W scales are drawn over the same length, and H=2 meters, then the distance from 18 to 19 on the BMI scale will need to be 4 times greater than the distance from 72 to 73 on the W scale, in order for the markings on the two scales to match and the pointer to be aligned correctly at the right measure on both scales. In some embodiments, a scale displaying weight, weight category and BMI using a single pointer may utilize the exemplary approach described above to calculate and display the measures.

[**0031**] In some embodiments consistent with the present invention, certain markings on the fixed scale may be positioned at a fixed visual angle. In some embodiments consistent with the present invention, the scales may be color-coded for easier readability. The plurality of scales with appropriate markings along with the single pointer are then displayed in step **260**. For each scale a "stretch factor," may be determined as the linear distance on the display corresponding to a unit increase in marker value on the scale. In some embodiments, the positions of markers on the display may be determined using the stretch factor. In some implementations, the user may be presented with several scale types, such as, for example, a linear scale type (with markings over straight lines), or a radial scale type (with markings over circular arcs) or a circular scale type (markings over the entire circumference of a circle), from which a particular scale type may be chosen for display. The chosen scale type is then used for each scale in the plurality of scales that are displayed in a manner consistent with embodiments of the present invention. In some embodiments, markers on a scale may serve to delimit categories. For example, a subject's weight category may be displayed on a scale based on the calculated BMI value. In this instance, markers on a weight category scale may simply be delimiters between

weight categories such as "Underweight,""Normal,""Overweight," or "Obese" that are displayed on the scale.

[0032] **FIGS. 3A and 3B** show a flowchart for an algorithm **300** for generating multiple scales with a single pointer according to embodiments of the present invention. A software application to perform steps in a method for the display of a plurality of anthropometric data is invoked and display parameters are entered in step **305**. In some embodiments consistent with the present invention, display parameters may be input by users, read from a file, or passed to the application from another program. In some embodiments consistent with the present invention, portions of the software application may reside on computing device **110**, server **130** or on removable media. In some embodiments, algorithm **300** may be implemented as a software module that is part of a software application implementing steps in flowchart **200**.

[0033] In flowchart **300**, the identifier "m" is used to refer to the values of the markers on a scale corresponding to anthropometric measurements, while the identifier "p" is used to refer to the positions of the markers on the display. The identifier "i" denotes the interval between markers on a scale. Subscripts to "m" and "p" identify the scale and marker in question. For example, p_{qr}, refers to the position of marker "q" on the scale "r." The subscripts "L" and "U" denote the lower and upper limits of the identifiers. The subscript "V" refers to the value being displayed on a particular scale by the pointer.

[0034] Data input, in step **305**, may include the type of scale, the length of the display D, the lower limit m_{FL}, and upper limit m_{FU} of the range of values displayed on the fixed scale, F, and the offset between the successive scales being displayed. In some embodiments, the offset, representing the distance between the scales, may be used to ensure that the scales do not overlap when displayed. In some embodiments, the type of scale may be linear, circular, radial or any other scale type according to embodiments of the invention. In some embodiments, a user may select a scale type from a menu of available scale types. In some embodiments, a scale type may be chosen by default. For the purposes of the exemplary algorithm described in flowchart **300**, a linear scale is assumed.

[0035] In step **310**, anthropometric values that have been input, measured, and/or calculated are retrieved. In some embodiments, the anthropometric values may be retrieved from memory, from storage, and/or received as parameters from another program. Anthropometric values are represented by markers on a scale, with a pointer indicating the displayed anthropometric value on each scale.

[0036] In step **315**, the display positions of the lower limit marker, p_{FL}, and upper limit marker, P_{FU}, and the interval between markers, i, for the fixed scale are received. In some embodiments, the offset between successive scales may be used in conjunction with the positions of the upper and lower limit markers on a scale, to calculate the positions of corresponding upper and lower limit markers on succeeding scales.

[0037] In step 320, the upper and lower limit marker values, m_{FU} and m_{FL}, for the exemplary linear scale are drawn. Additionally, the next marker value, m_{Fk}, to be displayed on the scale is calculated as $m_{Fk}=m_{Fl},+i$, by adding the interval between markers to the value of the lower limit marker, m_{FL}. A counter k, that keeps track of markers, is initialized to 1.

[0038] In step **325**, the position of the next marker value on the exemplary fixed linear scale is calculated. The position of the next marker value, p_{Fk}, is calculated as:

$$p_{Fk} = \frac{p_{FU} - p_{FL}}{m_{FU} - m_{FL}}(m_{Fk} - m_{FL}) + p_{FL}$$

where, the ratio $(p_{FU}-p_{FL})/(m_{FU}-m_{FL})$ may be seen as a "stretch factor," and determines the linear distance on the screen corresponding to a unit increase in marker value on the scale. In step **330**, marker value m_{Fk}, calculated in step **320**, is drawn at position p_{Fk}, calculated in step **325**. In step **335**, the next marker value, given by $m_{Fk}+i$, is compared with the upper limit of the marker value, m_{FU}. If $m_{Fk}+i \leqq m_{FU}$, then the current marker value is incremented, in step **340**, the counter k is incremented, and the process returns to step **325**. In some embodiments such as a scale divided into categories, the underlying metric used to determine the category may be used to generate markers at category transition points. For example, for a weight category scale, the underlying BMI marker value may be calculated and used to delimit a weight category at the appropriate position on the display. For example, at a position corresponding to a BMI marker value of 25, a marker may be drawn to delimit the "Normal" weight category from the "Overweight" weight category, according to Table 1.

[0039] If $m_{Fk}+i>m_{FU}$ then, in step **345**, a pointer is drawn pointing to the anthropometric value m_{Fv} for the fixed scale. The algorithm then proceeds to step **350**, as shown in **FIG. 3B**.

[0040] If there are additional scales that need to be drawn then, in step **355**, the display positions of the lower limit marker, p_{jL}, and upper limit marker, p_{ju}, of the next scale, j, are determined using scale offsets from step **305**. Additionally, the marker value for scale j is drawn at p_{jv}, which is the position of the pointer on scale j.

[0041] Next, in step **360**, the lower limit for marker value, m_{jL}, on scale j is calculated. In some embodiments, m_{jL} may be determined based on a formula used for the calculation of the derived anthropometric measures that are displayed using the scale. For example, if the height of a subject is 2 meters and the lower limit of a fixed BMI scale is 18 kilograms/meter^2, then the lower limit, W_L, on a weight scale may be calculated as $W_L=(18*2^2)=72$ kilograms. In addition, for the exemplary linear scale type, in flowchart **300**, the upper limit for marker value, m_{jU}, on scale j may be calculated as:

$$m_{jU} = \frac{p_{jU} - p_{jV}}{p_{jV} - p_{jL}}(m_{jV} - m_{jL}) + m_{jV}$$

using the known values of p_{jU}, p_{jL}, p_{jL}, m_{jL}, and m_{jV}. In some embodiments, the upper limit for marker value, m_{jU}, may be determined first based on a formula used for the calculation of the anthropometric measures that are dis-

played using the scale. Subsequently, the lower limit may be determined by using known values of p_{jU}, p_{jL}, p_{jV}, m_{jU}, and m_{jV}.

[0042] In step **365**, the upper limit marker value, m_{jU}, and lower limit marker value, m_{jL} are drawn at positions p_{jU} and p_{jL} respectively, on scale j. In addition, the value of the next marker m_{jk}, on scale j, is calculated as $m_{jk}=m_{jL}+i_j$, where i_j is the interval between markers for scale j.

[0043] In step **370**, the position of the next marker value on scale j is calculated. The position of the next marker value, p_{jk}, is calculated as:

$$p_{jk} = \frac{p_{jU} - p_{jL}}{m_{jU} - m_{jL}}(m_{jk} - m_{jL}) + p_{jL}$$

where, $(p_{jU}-p_{jL})/(m_{jU}-m_{jL})$ is the stretch factor for scale j.

[0044] Next, in step **375**, the marker m_{jk} is drawn at position p_{jk} scale j. In step **380**, the next marker value, given by $m_{jk}+i$, is compared with the upper limit of the marker value, m_{jU}, for scale j. If $m_{jk}+i \leqq m_{jU}$, then the current marker value is incremented, in step **385**. The counter k is also incremented, and the process returns to step **370**.

[0045] In step **380**, if $m_{jk}+i>m_{jU}$ then all of the markers for scale j have been drawn and the algorithm returns to step **350**. If no additional scales remain to be processed, in step **350**, the algorithm is terminated, in step **390**.

[0046] In some embodiments, the scales, markers, pointers, and all other objects may be drawn in a memory buffer prior to being rendered on a display device.

[0047] **FIG. 4** shows a display screen for an exemplary circular scale **500**, generated by a program that calculates and displays weight and BMI for a subject using a single pointer according to embodiments of the invention. In some embodiments, the raw anthropometric data pertaining to a subject may be entered at input locations **510** for height, and **520** for weight. Input boxes **510** and **520** can accept input in either metric units, or in feet/inches and pounds, or in British units such as stone (for weight). In general, input boxes **510** and **520** may be customized to accept data in a prevailing local standard for measurement. In some embodiments, a change from one set of units to another may be accomplished by selecting units on a unit selection box **550**, which offers alternate choices for units. Once a user has entered valid data, the program calculates BMI and displays the BMI value on a circular scale in conjUnction with the weight value entered at location **520**. The circular scale uses a single pointer **580**, to display the entered and calculated values for weight and BMI. For example, in the embodiment shown in **FIG. 4**, pointer **580** indicates a value of 82 kilograms for the weight, and 24 kg/m^2 as the BMI value. The scales shown contain individual markers with selected values depicted. The exemplary BMI scale displayed has a range from lower limit **570** with a value 18.5 kg/m^2 to upper limit **575** with a value of 40 kg/m^2. The exemplary weight scale displayed has range from lower limit **560** with a value of 60 kg to upper limit **565** with a value of 150 kg. In some embodiments, BMI indicator **530** and weight category indicator **540** also display the BMI and weight category values independently.

[0048] **FIG. 5** shows an exemplary radial scale **600** that displays weight, weight category, and BMI for a subject using a single pointer according to embodiments of the invention. Exemplary scale **600** shows fixed weight category scale **640**, weight scale **650** and BMI scale **660**, with the measured, entered and/or calculated values for weight, weight category and. BMI indicated by single pointer **690**. Weight category scale **640** has indicators using categories **610**, such as "Normal,""Underweight,"or "Overweight" to indicate weight category. Weight scale **650** and BMI scale **660** contain individual markers with selected values depicted. The exemplary weight scale displayed has a range from lower limit **620** with a value of 100 lbs. to upper limit **680** with a value of 200 lbs. The exemplary BMI scale displayed has a range from lower limit **630** with a value 15 kg/m^2 to upper limit **670** with a value of 27 kg/m^2. In exemplary scale **600**, as shown in **FIG. 6**, a weight category indicator may appear at a certain visual angle. For example, the "Overweight" category indicator appears to the right of the display. Exemplary scale **600** allows a user to intuitively and visually correlate raw anthropometric measures, such as weight, with derived anthropometric measures such as weight category, or BMI.

[0049] Further, methods consistent with embodiments of the invention may conveniently be implemented using program modules, hardware modules, or a combination of program and hardware modules. Such modules, when executed, may perform the steps and features disclosed herein, including those disclosed with reference to the exemplary flow charts shown in the figures. Embodiments of the invention may also relate to different types of anthropometric measures and/or scale types. The methods and algorithms described in the specification and examples may be extended and/or modified to additional measures and/or scale types. The operations, stages, and procedures described above and illustrated in the accompanying drawings are sufficiently disclosed to permit one of ordinary skill in the art to practice the invention. Moreover, there are many computers and operating systems that may be used in practicing embodiments of the instant invention and, therefore, no detailed computer program could be provided that would be applicable to these many different systems. Each user of a particular computer will be aware of the language, hardware, and tools that which are most useful for that user's needs and purposes.

[0050] The above-noted features and aspects of the present invention may be implemented in various environments. Such environments and related applications may be specially constructed for performing the various processes and operations of the invention, or they may include a general-purpose computer or computing platform selectively activated or reconfigured by program code to provide the finctionality.

[0051] Embodiments of the present invention also relate to computer-readable media that include program instructions or program code for performing various computer-implemented operations based on the methods and processes of embodiments of the invention. The program instructions may be those specially designed and constructed for the purposes of the invention, or they may be of the kind well known and available to those having skill in the computer software arts. Examples of program instructions include, for example, machine code, such as produced by a compiler, and

files containing a high-level code that can be executed by the computer using an interpreter.

[0052] Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the embodiments of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims. As such, the invention is limited only by the following claims.

1. A method of simultaneously displaying multiple anthropometric measures on a device, the method comprising:

accepting anthropometric data pertaining to a subject;

calculating derived anthropometric measures based on the accepted data;

selecting a plurality of anthropometric data for display; and

generating a scale corresponding to each selected anthropometric data; and

indicating the values of the selected anthropometric data on their respective scales in an analog format, using a single pointer.

2. The method of claim 1 wherein accepting anthropometric data pertaining to a subject comprises:

accepting raw anthropometric data pertaining to a subject; and/or

accepting other anthropometric data of the subject.

3. The method of claim 1, wherein selecting a plurality of anthropometric data for display comprises choosing at least one each of the raw anthropometric data, and the derived anthropometric measures.

4. The method of claim 1, wherein indicating the values of the selected anthropometric data on their respective scales in an analog format, using a single pointer further comprises aligning a marker on each scale corresponding to the value of anthropometric data for that scale, with a display window.

5. The method of claim 1, wherein indicating the values of the selected anthropometric data on their respective scales in an analog format, using a single pointer further comprises aligning a marker on each scale corresponding to the value of anthropometric data for that scale, with the single pointer.

6. The method of claim 1, wherein indicating the values of the selected anthropometric data on their respective scales further comprises generating images of the individual scales and the pointer.

7. The method of claim 1, wherein indicating the values of the selected anthropometric data on their respective scales in an analog format, using a single pointer further comprises:

aligning the single pointer to a value on a fixed scale corresponding to an anthropometric data selected for display; and

aligning the values on other scales corresponding to the remaining anthropometric data selected for display with the single pointer.

8. The method of claim 7 wherein the fixed scale may be color-coded.

9. The method of claim 1, wherein:

the accepted anthropometric data includes the height of the subject;

the accepted anthropometric data includes the weight of the subject; and

the derived anthropometric measures include the body mass index.

10. The method of claim 9, wherein the derived anthropometric measures further include the weight category of the subject.

11. The method of claim 10, where the weight category is selected from one of several weight categories based on the deviation of the weight of the subject from a norm.

12. The method of claim 10, where the weight category is chosen from one of underweight, normal, overweight, or obese.

13. The method of claim 1, wherein:

the accepted anthropometric data includes the age of the subject;

the accepted anthropometric data includes the gender of the subject;

the accepted anthropometric data includes the weight of the subject;

the accepted anthropometric data includes the maximum oxygen consumption of the subject; and

the derived anthropometric measures include the relative maximum oxygen consumption of the subject.

14. The method of claim 13, wherein the derived anthropometric measures further include the cardio-respiratory fitness category of the subject.

15. The method of claim 14, where the fitness category is selected from one of several cardio-respiratory fitness categories based on the deviation of the relative maximum oxygen consumption of the subject from a norm.

16. The method of claim 15, where the cardio-respiratory fitness category is chosen from one of very poor, poor, fair, average, good, very good and excellent.

17. An apparatus for simultaneously displaying multiple anthropometric measures on a device comprising:

means for accepting anthropometric data pertaining to a subject;

means for calculating derived anthropometric measures based on the accepted anthropometric data;

means for selecting anthropometric data for display;

means for generating a scale for each selected anthropometric data; and

means for indicating the anthropometric data value on each of the scales in an analog format using a single pointer.

18. The apparatus of claim 17, wherein means for accepting anthropometric data further comprises:

means for accepting raw anthropometric data; and/or

means for accepting other anthropometric data.

19. The apparatus of claim 17, wherein means for indicating the anthropometric data value on each of the scales in an analog format using a single pointer further comprises

means for aligning a marker on each scale corresponding to the value of anthropometric data for that scale, with a display window.

20. The apparatus of claim 17, wherein means for indicating the anthropometric data value on each of the scales in an analog format using a single pointer further comprises means for aligning a marker on each scale corresponding to the value of anthropometric data for that scale, with a pointer.

21. The apparatus of claim 17, wherein means for indicating the anthropometric data value on each of the scales in an analog format further comprises means for generating images of the individual scales and a pointer.

22. The apparatus of claim 17, wherein means for indicating the anthropometric data value on each of the scales in an analog format using a single pointer further comprises:

means for aligning a single pointer to a value on a fixed scale corresponding to one of the anthropometric data selected for display; and

means for aligning the values on other scales corresponding to the remaining anthropometric data selected for display with the pointer.

23. A method of simultaneously displaying multiple anthropometric measures on a device, the method comprising:

accepting height data of a subject;

measuring the weight of the subject;

calculating derived anthropometric measures based on the height and weight data of the subject;

selecting weight data, and at least one of the derived measured anthropometric measures for display;

generating a scale for weight, and a scale for each of the selected derived anthropometric measures; and

indicating the value of the weight, and the values of each of the selected derived anthropometric measures of the subject on their respective scales in an analog format, using a single pointer.

24. The method of claim 23, wherein calculating derived anthropometric measures comprises computation of the body mass index of the subject.

25. The method of claim 23, wherein calculating derived anthropometric measures comprises computation of the weight category of the subject.

26. A method of simultaneously displaying multiple anthropometric measures on a device, the method comprising:

accepting the age of a subject;

accepting the gender of the subject;

measuring the weight of the subject;

measuring the maximum oxygen consumption of the subject;

calculating derived anthropometric measures based on some or all of the accepted and measured data of the subject; and

selecting the weight, the maximum oxygen consumption, and at least one of the derived anthropometric measures of the subject for display;

generating a scale for weight, a scale for the maximum oxygen consumption, and a scale for each of the selected derived anthropometric data; and

indicating the values for weight of the subject, the maximum oxygen consumption of the subject, and values for each of the selected derived anthropometric measures of the subject on their respective scales in an analog format, using a single pointer.

27. The method of claim 26, wherein calculating derived anthropometric measures comprises computation of the relative maximum oxygen consumption of the subject.

28. The method of claim 26, wherein calculating derived anthropometric measures comprises computation of the fitness category of the subject.

29. A method of simultaneously displaying multiple anthropometric measures on a device, the method comprising:

accepting raw anthropometric data pertaining to a subject;

calculating derived anthropometric measures based on the raw anthropometric data;

selecting a plurality of anthropometric data for display;

generating a scale for each selected anthropometric data; and

indicating the values of the selected anthropometric data on their respective scales in an analog format, using a single pointer.

30. The method of claim 29, wherein selecting anthropometric data for display comprises choosing at least one each of the raw anthropometric data and the derived anthropometric measures.

31. The method of claim 29, wherein indicating the values of the selected anthropometric data on their respective scales in an analog format, using a single pointer further comprises aligning a marker on each scale corresponding to the value of anthropometric data for that scale, with a display window.

32. The method of claim 29, wherein indicating the values of the selected anthropometric data on their respective scales in an analog format using a single pointer further comprises aligning a marker on each scale corresponding to the value of anthropometric data for that scale, with the single pointer.

33. The method of claim 29, wherein indicating the values of the selected anthropometric data on their respective scales in an analog format using a single pointer further comprises generating images of the individual scales and the single pointer.

34. The method of claim 29, wherein indicating the values of the selected anthropometric data on their respective scales in an analog format using a single pointer further comprises:

aligning the single pointer to a value on a fixed scale corresponding to an anthropometric data selected for display; and

aligning the values on other scales corresponding to the remaining anthropometric data selected for display with the pointer.

35. The method of claim 34 wherein the fixed scale may be color-coded.

36. The method of claim 29, wherein:

the accepted raw anthropometric data includes the height of the subject;

the accepted anthropometric data further includes the weight of the subject; and

the derived anthropometric data includes the body mass index.

37. The method of claim 36, wherein the derived anthropometric data further includes the weight category of the subject.

38. The method of claim 37, where the weight category is selected from one of several weight categories based on the deviation of the weight of the subject from a norm.

39. The method of claim 29, wherein:

the accepted raw anthropometric data includes the age of the subject;

the accepted raw anthropometric data further includes the gender of the subject;

the accepted anthropometric data further includes the weight of the subject;

the accepted anthropometric data further includes the maximum oxygen; consumption of the subject; and

the derived anthropometric data includes the relative maximum oxygen consumption of the subject.

40. The method of claim 39, wherein the derived anthropometric data further includes the cardio-respiratory fitness category of the subject.

41. The method of claim 40, where the fitness category is selected from one of several cardio-respiratory fitness categories based on the deviation of the relative maximum oxygen consumption of the subject of the subject from a norm.

42. A computer-readable medium that stores instructions, which when executed by a computer perform steps in a method for displaying anthropometric data, the steps comprising:

accepting raw anthropometric data pertaining to a subject;

calculating derived anthropometric measures based on the raw anthropometric data;

selecting a plurality of anthropometric data for display;

generating a scale for each selected anthropometric data; and

indicating the values of the selected anthropometric data on their respective scales in an analog format, using a single pointer.

43. The method of claim 42, wherein accepting raw anthropometric data pertaining to a subject comprises accepting anthropometric data input from a measuring device.

44. The method of claim 42, wherein accepting raw anthropometric data pertaining to a subject comprises accepting anthropometric data input from a user.

45. The method of claim 42, wherein accepting raw anthropometric data pertaining to a subject comprises reading anthropometric data stored in machine-readable form.

46. The method of claim 42, wherein selecting a plurality of anthropometric data for display is based on predefined criteria stored by a user.

47. The method of claim 42, wherein displaying the selected anthropometric data on a plurality of scales in an analog format using a single pointer is performed on a monitor.

48. A computer readable memory containing instructions for controlling a computer system to perform steps in a method for displaying anthropometric data, the steps comprising:

accepting raw anthropometric data pertaining to a subject;

calculating derived anthropometric measures based on the raw anthropometric data;

selecting a plurality of anthropometric data for display;

generating a scale for each selected anthropometric data; and

indicating the values of the selected anthropometric data on their respective scales in an analog format, using a single pointer.

49. A computer processor executing instructions that performs steps in a method for displaying anthropometric data, the steps comprising:

accepting raw anthropometric data pertaining to a subject;

calculating derived anthropometric measures based on the raw anthropometric data;

selecting a plurality of anthropometric data for display;

generating a scale for each selected anthropometric data; and

indicating tie values of the selected anthropometric data on their respective scales in an analog format, using a single pointer.

* * * * *

专利名称(译)	用于数据可视化的系统和方法		
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摘要(译)

与本发明的实施例一致的系统和方法提供了一种使用单个指针以模拟格式在多个尺度上显示人体测量测量的方法。在一些实施例中，选择用于显示的多个数据可包括原始和衍生的人体测量数据。在一些实施例中，所显示的原始数据可以包括受试者的体重，并且所显示的衍生数据可以包括受试者的BMI和体重类别。在与本发明一致的一些实施例中，指针可以对应于对应于人体测量度量的固定标度，并且其他标度可以与指针对准以对应于由各个标度表示的人体测量度量。在一些实施例中，一些或所有标度可以是颜色编码的。