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(54) **An apparatus for determining a dimension of a selected surface of an object**

Vorrichtung zur Bestimmung der Abmessung einer ausgewählten Oberfläche eines Objekts

Appareil pour déterminer une dimension d'une surface donnée d'un objet

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Description

FIELD OF THE INVENTION

[0001] The present invention generally relates to electronic measuring systems and apparatuses for electronically measuring physical dimensions of an object and, more particularly to an apparatus configured to be used with a processing unit for determining a dimension of a selected surface of an object. In particular, the object may be a 3D-object and the selected surface may be a 3D-surface.

BACKGROUND OF THE INVENTION

[0002] Systems, apparatuses and methods of measuring physical dimensions of a body are useful in a variety of applications, among others, for taking a person's body measurements for garment tailoring purposes.

[0003] Traditional systems, apparatuses and methods of measuring physical dimensions of a body for tailoring purposes generally use manual measuring means, such as a measuring tape. The steps taken in tailoring a suit are familiar to anyone who has purchased a piece of cloth. The customer chooses a piece of cloth and then seeks assistance for taking a number of body measurements in order to alter the suit to fit the size of the customer. Sometimes the customer is fortunate enough to have the tailor take the measurements. The tailor will know if special considerations are required for the shape of the customer or the style of the suit. If this is the case, certain additional measurements may be necessary over and above the half dozen or so measurements normally taken. If, as an example, the customer has an athletic build with well developed thigh and bleep muscles, yet normal waist and shoulder measurements, additional measurements may be required to enable the tailor to produce a well fitting suit. It is also possible for the well-trained tailor to spot specifics in posture which may require additional measurements to be taken to more precisely match the suit to the customer.

[0004] In many retail stores, however, a tailor is not present at the store and the measurements are rather taken by a store clerk who may not know which measurements are needed for a particular individual. The tailor operates at a distinct disadvantage when alterations are made since he will undoubtedly tailor the suit to the universal build and posture rather than what may be a very uniquely proportioned person. In these instances, the clerk's measurements may result in only an average fit. Besides, the measurements taken by the store clerk should usually be sent manually to the tailor who is usually located in another location. This process of taking measurements is time consuming and usually results in inaccurate measurement results and defective tailored garments.

[0005] Recent developments in the field of data processing and electronics resulted in developing special technologies for electronically measuring physical dimensions of a human's body. Noticeable examples of the prior art are U.S. Pat. No. 7,253,766, to Foote et Al. (2007), U.S. Pat. No. 6,415,199, to Liebermann (2002), U.S. Pat. No. 4,885,844, to Chun (1989), U.S. Pat. No. 4,868,990, to Steinberg (1989), U.S. Pat. No. 4,635,367, to Vigede (1987), and U.S. Pat. No. 3,979,831, to Lutz (1976). Other examples of prior art are US Pat. Nos. US 4,635,367, US 4,586,150, US 5,691,923, US 5,956,525.

[0006] US Patent '367 suggests use of electrical connectors connected to a plurality of measuring points distributed over a body suit, where the electrical connectors detect emplacement of said measuring points when the body suit is worn by a person and transmit electrical signals representing said emplacements to be stored in storage means. This technology also suggests, as an alternative, optical sensors for detecting these measuring points. The measuring points are disposed on a tape that should be manually adjusted (by the tailor) according to the wearer's size.

[0007] US Patent '150 teaches a hand held device for taking measurements. The device measures a distance between two points by extending a wire therebetween and by measuring the equivalent voltage of the wire. Since the voltage is proportional to the length of the wire, the distance between the two points is therefore determined. The measurements are sent by a transmitter to a receiver in order to be stored for potential use.

[0008] US Patent '923 suggests a beacon device using a measuring tape having regularly-spaced markers and electronic sensing means for detecting passage of the markers. Once, the maker is detected, the measured distance is converted into an electrical signal and transmitted to be recorded.

[0009] US Patent '525 suggests use of a multi-view camera arrangement for building a three dimensional profile of a person.

[0010] US 2010/275338 and US 2003/036858 disclose garments with sensors for detecting shape-related parameters.

[0011] While these traditional measuring systems, apparatuses and methods may provide means for measuring physical dimensions of a person, these technologies require a human intervention in order to carry out at least some operations. Moreover, these technologies are complex, high costly and unreliable in certain circumstances. In fact, they generally do not provide substantially accurate measurement of the physical dimensions of a body, are complex and expensive to produce and generally require specialized training of persons using these systems and apparatuses. Besides, some of the associated equipments required to execute the measurements are generally cumbersome and, thus, are not in a compact format for facilitating the measurement process. Another limitation of these traditional systems and appartuses is that, in being voluminous, they are unsuitable for shipping through regular post mail. Such a constraint is particularly disadvantageous in a growing

global market environment and purchases of garments made by private individuals through Internet.

SUMMARY OF THE INVENTION

[0012] It is a general object of the present invention to provide a new and improved apparatus that overcome the above-mentioned drawbacks.

[0013] As a first aspect of the invention, there is provided an apparatus according to claim 1.

[0014] The beacon devices can be considered as markers or references of the system to be able to determine the shape and measurements of the dimensions

[0015] A spatial configuration can be seen as a map defining where each beacon device of the beacon devices is located within the surface of the object. This generally requires an indication of the exact location (distance and orientation) of each beacon device with respect to the other beacon devices.

[0016] Preferably, the processing unit is part of a remote computer system, the apparatus further comprising communication means adapted to be connected to a data network for remotely transmitting the data representing the second spatial configuration to the processing unit.

[0017] According to the invention the electronic means comprise distance measuring means. The distance measuring means allow for determining a shifting length and a shifting orientation of each one of the beacon devices when the beacon devices shift position.

[0018] As will be illustrated hereinafter, in order to determine the shifting orientation, generally it is not required to have other means beside the distance measuring means. In most cases, the shifting orientation of a given beacon device can be determined by comparing the relative shifting length of the given beacon device with respect to its adjacent beacon devices. For instance, if a given beacon device (A) has four adjacent beacon devices (B,C,D and E) which are respectively located at 0, 90, 180 and 270 degrees from the given beacon device, by measuring the shifting length of the given beacon device with respect to each one of these adjacent beacon devices, the shifting orientation can be determined, and hence no other measuring means beside the distance measuring means are required.

[0019] Preferably, the distance measuring means comprise uniquely identified rotary encoders disposed within at least a part of the uniquely identified beacon devices in accordance with a rotary encoder configuration known a priori, wherein the rotary encoders comprise input rotatable shafts coupled to spring loaded reels storing strings, where the strings have a first end folded within the spring loaded reels and a second end extending therefrom and attached to attachment points located at selected directions in accordance with the rotary encoder configuration, such that when the beacon devices shift position, the strings unfold and engage the input rotatable shafts to rotate proportionally to the shifting.

[0020] The strings are non-stretchable strings and the rotary encoders are configured to output rotational values proportional to the shifting when the input rotatable shafts rotate, where the shifting length and shifting orientation of each one of the beacon devices is determined as a function of the rotary encoder configuration and the rotational values.

[0021] In other terms, the rotary encoders are disposed in accordance with a rotary encoder configuration which is determined a priori and known a priori by the processing unit. The rotary encoder configuration can be seen as a map defining where each rotary encoder is located within the surface of the object to measure and where (distance and orientation) it's corresponding attach point is located with respect thereto. Each rotary encoder is uniquely identifier by a unique rotary identifier such that each rotational value can be associated with a given rotary encoder. Besides, the strings should be non-stretchable strings for enabling the input rotatable shafts to rotate proportionally to the tension exercised on the fabric. Otherwise (if the strings where stretchable), this tension would be at least partially dissipated by stretching the strings and the rotation of the rotary encoders would not be proportional to the exercised tension.

[0022] Preferably, the apparatus further comprises a central communication unit and communication means connected to the beacon devices and to the central communication unit, where the central communication unit receives the rotational values from the beacon devices, maps each rotational value among the rotational values with a corresponding rotary encoder among the rotary encoders by which it was generated, and remotely transmits the mapped rotational values to the processing unit.

[0023] The central communication unit can be connected directly to each rotary encoder for receiving the rotational values. Since the rotary encoders are uniquely identified, the central communication unit receives the rotational values and maps each read rotational value to the unique identifier of the rotary encoder by which it was generated. In other terms, the central communication unit generates a data matrix storing the rotational values in association with their respective unique rotary identifiers. A mapped rotational value is essentially a vector comprising a rotational value and its corresponding unique rotary identifier.

[0024] Preferably, the processing unit is part of a remote computer system, the central communication unit further comprising a network interface adapted to be connected to a data network for remotely transmitting the mapped rotational values to the processing unit. It should be understood that the data network can comprise more than one data network. For instance, it can comprise a Wi-Fi data network for transmitting the data to an intermediary computer system and of the Internet for transmitting the data from the intermediary computer system to the processing unit that can be located within a remote computer system with respect to the intermediary computer system and connected to the Internet.

[0025] Preferably, the beacon devices comprise stor-

age means for storing the rotational values, wherein the communication means are connected to the storage means for retrieving the rotational values. It should be understood that the stored rotational values should be stored in such a manner that the central communication unit can associate each rotational value with a unique rotary identifier.

[0026] Preferably, the beacon devices are disposed on the piece of fabric in a two dimensional array configuration such that each beacon device has a number of adjacent beacon devices located at different directions thereof. It should be understood that a two dimensional array configuration would allow measuring a surface in opposition to a one dimensional array that only allows for measuring a length. The attach points can consist of dump beacon devices selected among the beacon devices. It should be understood that dump beacon devices are meant to be non-intelligent beacon devices that are essentially used as attach points. Generally, they do not comprise rotary encoders nor are they connected to the distance measuring means and to the central communication unit.

[0027] Preferably, each one of the beacon devices comprises a number of rotary encoders equivalent to the number of adjacent beacon devices such that each pair of rotary encoders located within adjacent beacon devices are linked therebetween by a common string extending from their respective spring loaded reels.

[0028] As mentioned hereinabove, in order to determine the second spatial configuration of the beacon devices (when the fabric is draped over the surface of the object and is stretched), rotary encoders can be used which would allow measuring rotational values thereof which are proportional to the shifting amount of the beacon devices. However, there are other means for determining the second spatial configuration of the beacon devices. In fact, what is important is to measure the shifting (distance and orientation) of the beacon devices with respect to their first spatial configuration. Since the original distances and orientations between the beacon devices (when the fabric is not stretched) are know a priori, the objective is to determine the relative distances and orientations between the beacon devices after that fabric is draped over the surface of the object and is stretched. A person skilled in the art should understand that the means for measuring these relative positions can vary.

[0029] In another preferred embodiment, the distance measuring means comprise uniquely identified wire loaded reels disposed within at least a part of the uniquely identified beacon devices in accordance with a reel configuration known a priori, wherein the wire loaded reels store electrical wires having a first end folded within the wire loaded reels and a second end extending therefrom and attached to attach points located at selected directions in accordance with the reel configuration, such that when the beacon devices shift position, the electrical wires unfold and extend in length proportionally to the shifting.

[0030] Preferably, the distance measuring means further comprise electrical means for measuring electrical properties of the wires when unfolded by effect of the shifting, the electrical properties varying as a function of lengths of the wires, where the shifting length and shifting orientation of each one of the beacon devices is determined as a function of the reel configuration and the measured electrical properties. Preferably, the electrical properties consist of electrical resistances or conductances of the wires.

[0031] Preferably, the apparatus further comprises a central communication unit and communication means connected to the beacon devices and to the central communication unit, where the central communication unit receives the measured electrical properties from the beacon devices, maps each measured electrical property among the measured electrical properties with a corresponding wire reel among the wire reels associated therewith, and remotely transmits the mapped measured electrical properties to the processing unit.

[0032] Preferably, the processing unit is part of a remote computer system, the central communication unit further comprising a network interface adapted to be connected to a data network for remotely transmitting the mapped measured electrical properties to the processing unit. Preferably, the beacon devices comprise storage means for storing the measured electrical properties, wherein the communication means are connected to the storage means for retrieving the measured electrical properties.

[0033] Preferably, the beacon devices are disposed on the piece of fabric in a two dimensional array configuration such that each beacon device has a number of adjacent beacon devices located at different directions thereof. The attach points can consist of dump beacon devices selected among the beacon devices.

[0034] Preferably, each one of the beacon devices comprises a number of wire loaded reels equivalent to the number of adjacent beacon devices such that each pair of wire loaded reels located within adjacent beacon devices are linked therebetween by a common electrical wire extending from their respective wire loaded reels.

[0035] Preferably, the object to measure is a part of a human body and the piece of fabric is a garment.

[0036] Other advantages and novel features of the present invention will be more apparent from the following drawings and detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] **Figure 1** shows a general view of an apparatus comprising a garment for measuring the upper part of a person's dimension in accordance with an embodiment of the present invention;

[0038] **Figure 2** depicts in an enlarged partial view of the section II of Figure 1, wherein adjacent beacon devices are shown with a top portion removed for a better view of their internal structure;

[0039] **Figure 3** depicts an enlarged view of a beacon device;

[0040] **Figure 4** illustrates a communication connection established between the central communication unit of the apparatus in accordance with the present invention and a remote computer system; and

[0041] **Figure 5** depicts, in a partial view, a pair of beacon devices connected by a multiconductor wire.

DETAILED DESCRIPTION OF THE INVENTION

[0042] **Figure 1** illustrates an electronic measuring apparatus **10** according to a preferred embodiment of the present invention. The electronic measuring apparatus **10** comprises a body suit **12**, a plurality of beacon devices **16** (see Figure 2) and a central communication device **20**. The present apparatus will be illustrated for measuring physical dimensions of a person, however it shall be understood that the present apparatus can be used to measure any object. In the present, an "object" is referred to be anything that is tangible and can be a person, an animal or a thing or any physical part thereof.

[0043] Though the body suit **12** is herein represented by a conventional T-shirt, it is to be understood that the body suit **12** may be represented by any other suitable piece of garment such as a long sleeve shirt, a pair of long pants, a pair of short pants, socks, gloves, a bonnet style head cover and a full body suit. In fact, the form of the body suit **12** shall be suited with the form of the object whose dimensions are to be measured. For example, if the objective is to measure a leg of a person, the body suit **12** shall comprise a piece of garment suitably fabricated to fit a leg of a human being. On the other hand, if the objective is to measure the physical dimensions of an animal body (ex. a dog), the body suit **12** shall comprise a piece of garment appropriately conceived to take the form of that animal.

[0044] The body suit **12** is made of a stretchable material, where the material has a non-stretched state when the body suit **12** is unworn (i.e. initial state), and is stretched by a given stretched amount when the body suit is worn (i.e. final state). The body suit **12** is preferably dimensioned such that it is slightly smaller than the regular clothing size of the wearer. Thus, once the body suit **12** is worn, it is stretched and closely conforms to the body portion of the wearer that it is designed to cover. Preferably, the stretchable property of the body suit **12** is such that a same size of the body suit **12** may be suitable to comfortably and closely conform to the body of wearer's who normally wear substantially different sizes of clothing. Thus, a relatively small number of a body suits **12** (ex. small, medium, large and extra-large sizes) may be sufficient to measure the body dimensions of a fairly large proportion of the population.

[0045] The electronic measuring apparatus **10** comprises a plurality of beacon devices **16** spatially distributed within the body suit **12**. The beacon devices **16** are spatially arranged in an appropriate configuration, such as a substantially array configuration, a partial array configuration or a daisy-chained configuration. Each beacon device **16** is uniquely identified and is located at a predetermined specific location of the body suit **12.** Moreover, at an initial state (where the body suit is in a non-stretched state), the beacon devices are physically distant with respect to each other by a pre-determined and *a priori* known distance (initial distance). The specific configuration of the beacon devices at this initial state is referred to as "a first spatial configuration".

[0046] When the body suit is worn by a person, the body suit is stretched, and thus the beacon devices shift position with respect to each other and the distance therebetween increases (final distance). By measuring the final distance between the beacon devices **16**, it is possible to determine the difference between the initial distance and the final distance therebetween (delta distance). In order to measure the final distance, each beacon device 16 is configured to obtain various measurement values of distance (and orientation) with respect to adjacent beacon devices **16**. In a preferred embodiment, these measurement values are time stamped. This final disposition of the beacon devices (after the body suit is stretched) is referred to as "a second spatial configuration".

[0047] It should be understood that when it is referred to the distance between the beacon devices, it is meant to refer to a set of distance values that can be represented by a data matrix, where each value thereof represents a distance between two beacon devices. Thus, the initial distance, the final distance and the delta distance can be represented by data matrices comprising a set of distance values, where each value represents a distance between two adjacent beacon devices. These values would allow for determining the second spatial configuration. The first and second spatial configurations would allow for determining the physical dimensions of the wearer wearing the body suit **12**.

[0048] Now referring more particularly to **Figure 3**, each beacon device **16** comprises distance measuring means **18** for measuring the various distances between said beacon device and adjacent beacon devices, storage means **42** for storing the obtained measured distance values, communication means **44** for transmitting the measured distance values (and other measured values if it is the case) to a central communication unit **20**, and a support **24** on which the various components of the beacon device **16** stand.

[0049] **Figure 2** shows a particular array configuration of the beacon devices **16** according to a preferred embodiment. Accordingly, the beacon devices **16** have a square shape and are arranged in a matrix form configuration such as each beacon device has four adjacent beacon devices. The distance measuring means **18** can be configured such that the various distances between a given beacon device and adjacent beacon devices are measured. It should be understood that according to a preferred embodiment, the distance measuring means

18 allow for measuring the distances between a given beacon device and four adjacent beacon devices, however a person skilled in the art shall understand that it is possible to measure the distances between a given beacon device and a superior or an inferior number of adjacent beacon devices, which would respectively increase or decrease the resolution (precision) of the measuring apparatus **10**. In other terms, the resolution of the measuring apparatus **10** can be increased or decreased by engaging an appropriate number and configuration of beacon devices **16** such that the number of adjacent beacon devices is respectively increased or decreased.

[0050] According to the preferred embodiment, the distance measuring means **18** are preferably distributed about a circumferential edge of each beacon device **16**. The distance measuring means **18** are preferably mounted on a suitable support element **24** such as a printed circuit board, or the like.

[0051] According to the preferred embodiment, the distance measuring means **18** comprise at least one rotary encoder **26** having an input rotatable shaft **28** and a spring loaded reel **30** coupled thereto, where the spring loaded reel **30** stores one end of a non-stretchable string **32**. The number of rotary encoders **18** is determined as a function of a number of adjacent beacon devices which distances shall be measured with respect to a first beacon device.

[0052] It is to be understood that, although the input rotatable shaft **28** is shown projecting perpendicularly from the surface of the substantially planar support **24,** the input rotatable shaft **28** may as well be projecting in a parallel orientation relative to the support **24**, and at an angle relative to the circumferential edge of the latter.

[0053] Each rotary encoder **26** disposed on a first edge of a first beacon device **16** is adapted to be in cooperative relation with a corresponding rotary encoder **26** disposed on a facing edge of an adjacent beacon device **16**. Thus, as illustrated in **Figure 2**, a pair of cooperating rotary encoders **18** located on opposing facing edges of two adjacent beacon devices **16** may share a single string **32** having its ends wrapped around their respective spring loaded reels **30**. At least one of the rotary encoders **18** provides rotational measurement values of the rotatable reel **30**.

[0054] At an initial state, when the body suit **12** is unworn, the input rotatable shafts **28** associated with the rotary encoders **18** are immobile and the strings extending between the cooperating rotary encoders **18** have a first length. When the body suit **12** is worn, at least a part of the body suit **12** stretches as a function of the physical dimensions of the wearer. The effect is that the beacon devices shift position and the distance between the beacon devices **16** located within the stretched part of the body suit **12** increases and the input rotatable shafts **28** associated with the rotary encoders **26** rotate. The string extending between each two adjacent rotary encoders **26** extends and reaches a final length. The rotating amount of each input rotatable shaft **28** is measured and stored inside the storage means **42** of its corresponding beacon device **16**. This value allows for determining the final string length. Thus, a pair of rotary encoders **18** allows for accurately measuring the distance between two adjacent beacon devices **16**.

[0055] It is to be understood that rotary encoders **18** can be replaced by any other suitable distance measuring means that would allow determining a distance between two adjacent beacon devices **16**. For instance, the rotary encoders can be replaced by uniquely identified wire loaded reels disposed within the beacon devices in accordance with a reel configuration known a priori, where the wire loaded reels store electrical wires, such that when the beacon devices shift position, the electrical wires unfold and extend in length proportionally to the shifting. Since an electrical property of an electrical wire vary as a function of its length, the distance measuring means can comprise electrical means for measuring electrical properties of the wires when unfolded by effect of the shifting. Such electrical properties can be capacitances or inductances of the wires.

[0056] Moreover, but not according to the invention, would be possible to use stretchable strings (instead of non-stretchable strings) and to measure the tension of these strings when the beacon devices shift position. Also, it would be also possible to use a proximity sensor technology that would allow measuring the relative distance between two adjacent beacon devices. By using such proximity sensor technology, there is no need to engage a string or any other physical connection between the beacon devices **16**.

[0057] As shown in **Figures 2 and 3,** a beacon device **16** may have a substantially planar and square shape, and include four rotary encoders **18** equidistantly disposed about the circumference thereof. The beacon device **16** may be encased in any suitable shield case, such as a molded plastic housing or the like, for protection and durability. The shield case may have suitably disposed lateral holes for freely engaging each outwardly extending string **32** of the rotary encoders **18**.

[0058] It is to be understood that, although the beacon devices **16** illustrated in **Figures 2 and 3** have a substantially square and planar shape, a beacon device **16** may have any other suitable shape. For example, a beacon device **16** may have a substantially two-dimensional, rounded, triangular, octagonal, or oval shape, or the like, or even a freeform shape. A beacon device **16** may as well have a three-dimensional spherical, triangular, rectangular, or cubic shape, or the like, or even a freeform shape.

[0059] As mentioned above, the distance measuring means **18** located within a first beacon device **16** can be adapted to measure the distance between said first beacon device and at least one adjacent beacon device. The strings **32** may extend around the circumference of a two-dimensional beacon device **16**, or extend outwardly from the outer surface of a three-dimensional beacon device (not shown). Furthermore, the extending strings **32** need

not to be equidistantly distributed around the circumferential edge of a two-dimensional beacon device **16** or about the surface of a three-dimensional beacon device. For example, the extending strings **32** of a plurality of rotary encoders **18** located within a same beacon device **16** may all be outwardly extending from selected positions along a same edge, or along a same surface portion of the device **16**.

[0060] The apparatus **10** of the present invention may include a combination of beacon devices **16** having a combination of two-dimensional and three-dimensional shapes. It is to be noted that beacon devices **16** having a two-dimensional or a three-dimensional freeform shape may be advantageously used with a body suit **12** having portions adapted to comfortably cover challenging parts of a wearer's body such as the arm pits or ankles of the wearer.

[0061] In another embodiment of the present invention, the beacon device **16** may also comprise an accelerometer **36**, a timer **38** and a central processing unit (CPU) 40. The accelerometer **36** may consist of a conventional accelerometer that is commonly found in cellular phones, video game devices, or the like, and is configured to measure the relative angular movement in space of the beacon device **16**. The timer **38** may consist of a conventional timer and is designed to provide a time stamped value that may be associated with other measurement values obtained by the beacon device **16**. The CPU **40** can be connected to the storage means **42** for managing software execution and data storage associated with the beacon device operation. However, for complexity reasons, it would be preferable not to include a CPU within the beacon devices.

[0062] It is to be understood that the various elements of the beacon device **16** described herein may be embedded within an integrated circuit (IC) mounted on the support element **24** for obtaining a beacon device **16** having a relatively compact format.

[0063] The communication means **44** preferably comprise a data transmitting module connected to the storage means **42**, a data communication network and a network interface for transmitting the measurement values (i.e. distance and angular movement values if it is the case) to the central communication unit **20.** The data transmitting module can consist of a wireless transmitter or any other appropriate module (wireless or not) for transmitting data to the central communication unit **20**. Furthermore, it is be understood that the storage means **42** can consist of a memory or any other electronic component (ex. a multiplexer) configured to receive and store data at least temporally. Thus, the communication network interface unit **44** of each beacon device **16** is connected to the central communication unit **20** through the data communication network. In other terms, the central communication unit **20** is connected, through the data communication network, to each one of the beacon devices for receiving measurement data thereof. Preferably, the central communication unit **20** has a relatively small size, and may be affixed to an edge portion of the body suit as illustrated by **Figure 1**.

[0064] In a preferred embodiment, the data communication network used for communicating data between the central communication unit **20** and the beacon devices **16** is a wire communication network having a daisy-chained configuration. In this optic, as illustrated in **Figure 4,** the central communication unit **20** is connected to a first beacon device **16** using a flexible multiconductor wire **46**. The wire passes through all the beacon devices, from one beacon device to another in a daisy-chain configuration. As illustrated in **Figure 5**, the flexible multiconductor wire between two beacon devices **48** shall have a total length that is at least equivalent to the maximum stretchability between two adjacent beacon devices. It is to be noted that the multiconductor wires may be replaced with a substantially flat and flexible printed circuit conductors (not shown). In another embodiment, the bi-directional data communication network used for communicating data between the central communication unit **20** and the plurality of beacon devices **16** consists of a bi-directional radio-frequency (RF) based communication network. Such a wireless communication network may comprise, for example, a low-power, bi-directional RFID technology (Radio-Frequency interference **ID**entification technology), or the like.

[0065] As illustrated in **Figure 4**, the central communication unit **20** is remotely connected via a data network to a remote computer system **22** for transmitting thereto the measurement values received from the beacon devices for further processing. The data network can consist of either a wired or a wireless communication network (such as the Internet or a satellite). The central communication unit **20** comprises a central processing unit (CPU) **52**, storage means **54**, a network interface **56**, and a rechargeable power battery **58**.

[0066] The network interface **56** is used as an interface for connecting the central communication unit **20** to the beacon devices **16** using the multiconductor wire **46**. The communication network interface 56 also serves as a communication interface between the central communication unit **20** and the remote computer system **22**. The connection between the communication network interface **56** and the remote computer system **22** may be a wired type connection such as, for example, a conventional USB (Universal Serial Bus) connection, a broadband cable connection, or the like, or may be a wireless type connection such as, for example, a Bluetooth™ or Wi-Fi wireless network connection, or the like. Preferably, the central communication unit **20** communicates with the remote computer system **22** through a wireless connection, such as a Bluetooth™, satellite or Wi-Fi connection.

[0067] The electronic measuring apparatus can be used in connection with a plurality of applications, such as e-commerce applications. In the context of e-commerce, the remote computer system **22** can be a mediator server (electronic market database) connected to the In-

ternet and listing clothing items for trade. The mediator server can comprise a web-based application allowing users to select a given clothing item for purchase and to upload measuring values obtained by the electronic measuring apparatus located at the user side. This is particularly useful where the user wishes to order a customized size of an clothing item to purchase, in order to fit with his irregular body size (ex. long legs, broad shoulders, thick neck, etc.).

[0068] The rechargeable power battery **58** provides power to the central communication unit **20** as well as to the beacon devices **16** if necessary via the multiconductor wires **48** or independent wires. Preferably, the rechargeable power battery is recharged through the USB connection. Alternatively, the rechargeable battery can also be recharged with an independent power source.

[0069] The CPU **52** manages all the operations of the central communication unit **20** for receiving the data from the beacon devices, storing it into the storage means **54** and for transmitting it to the remote computer system **22** through the communication network interface **56**. The central communication unit **20** is preferably affixed to a suitable portion of the body suit **12** in a way that does not interfere with the relative movement between the beacon devices **16**.

[0070] The functionalities of the apparatus **10** may be generally described as follows. As a first step, the body suit **12** is preferably hanging on a cloth hanger, or laid flat on a substantially planar surface, such that the distance measuring means 18 between the beacon devices **16** are in a substantially unstretched state. In a second step, a reset signal is transmitted to each of the beacon devices **16** for resetting to zero each of its onboard distance measuring means **18**, its accelerometer unit **36** and its timer unit **38**. The reset signal can be initiated by the remote computer system **22**, locally using an appropriate reset switch connected to the central communication unit **20** or automatically when the body suit is in a non-stretched state.

[0071] In a third step, a wearer (desiring to measure his physical size) wears the body suit **12** in a most natural and comfortable fashion while preferably standing up. During this operation, the beacon devices **16** measure a number of rotations engaged by each springloaded reel **30** of each beacon device **16**. A first reading is taken at a first moment, such as when a person inhales, and a second reading is taken in a second moment, such as when a person exhales. These values, along with the values obtained by the accelerometer unit 36 and the timer unit **38** (if it is the case), are stored into the storage means **42** of the corresponding beacon device **16**.

[0072] In a fourth step, each one of the beacon devices transmit the data stored within its storage means **42** along with a unique identifier associated with the corresponding beacon device 16 to the central communication unit **20** for storage into the storage means thereof **54**. This operation can be initiated either automatically or following a request from the central communication unit **20**. In a fifth step, the central communication unit **20** transmits the stored data to the remote computer system **22** for further processing. This operation can be initiated either automatically by the central communication unit **20** or upon a request from the remote computer system **22**.

[0073] Finally, the data (representing the rotational measurement values) may then be processed by the remote computer system for determining the second spatial configuration first, and then for determining the physical dimensions of the wearer by compiling the first and second spatial configurations using an appropriate software. The distances between the beacon devices are already stored in the central communication unit. Each two beacon devices have their distance values assigned to zero after the reset stage (first stage). After the person puts on the cloth or whatsoever, the distances between these beacon devices change and so are the values which are being stored and known already in the central unit. In combination with the accelerometer position the shape of the body that wore the cloth etc can be determined. Each angle of the reel would be noticed in the software as a specific distance (e.g. I mm). Each reel of course has a maximum measurement that it can measure. The result of the processed data may then be used to select or custom tailor garments having compatible clothing sizes with the wearer of the measuring apparatus.

[0074] Among the advantages of the present measuring apparatus **10** are that it is relatively easy to use by a common person for accurately measuring physical dimensions of a wearer. Also, the apparatus is relatively easy and economical to manufacture and it can be easily folded into a compact format for shipping by regular post mail, thus avoiding a potential customer to travel long distances to try a specific piece of garment at a retail store.

[0075] The features disclosed in the foregoing description, in the claims and/or in the accompanying drawings may, both separately and in any combination thereof, be material for realising the invention in diverse forms thereof. The invention is only defined by the appended claims.

Claims

1. An apparatus (10) configured to be used with a processing unit (22) for determining a dimension of a selected surface of an object, said apparatus comprising:

a measuring garment (12) having a shape adapted to fit said selected surface of said object such that said measuring garment stretches proportionally, to said dimension of said surface when draped thereover;

a plurality of uniquely identified beacon devices (16) disposed on said measuring garment when unstretched in accordance with a first spatial configuration known a priori, where,

when said measuring garment is draped over and stretched by said surface, said beacon devices (16) automatically shifts position and forms a second spatial configuration as a function of said dimension of said surface; and
electronic means for detecting said second spatial configuration and for generating data representing said second spatial configuration, wherein said electronic means comprise distance measuring means (18) and wherein the distance measuring means (18) comprise at least one rotary encoder (26) having an input rotatable shaft (28) and a spring loaded reel (30) coupled thereto, where the spring loaded reel (30) stores one end of a non-stretchable string (32), wherein each rotary encoder (26) is disposed on an edge of a first beacon device (16) and adapted via the string to be in cooperative relation with a corresponding rotary encoder (26) disposed on a facing edge of an adjacent beacon device (16);
where said processing unit (22) is configured to receive data associated with said first and second spatial configurations and to determine said dimension of said surface as a function thereof.

2. The apparatus as claimed in claim 1, wherein said processing unit (22) is part of a remote computer system, said apparatus further comprising communication means adapted to be connected to a data network for remotely transmitting said data representing said second spatial configuration to said processing unit.

3. The apparatus as claimed in claim 1, wherein said distance measuring means (18) allow for determining a shifting length and a shifting orientation of each one of said beacon devices (16) when said beacon devices shift position.

4. The apparatus as claimed in claim 3, wherein said rotary encoders are uniquely identified rotary encoders disposed within at least a part of said uniquely identified beacon devices (16) in accordance with a rotary encoder (18) configuration known a priori, wherein said rotary encoders comprise input rotatable shafts coupled to spring loaded reels storing strings (32), where said strings (32) have a first end folded within said spring loaded reels and a second end extending therefrom and attached to attachment points located at selected directions in accordance with said rotary encoder (18) configuration, such that when said beacon devices (16) shift position, said strings (32) unfold and engage said input rotatable shafts to rotate proportionally to said shifting.

5. The apparatus as claimed in claim 4, wherein said non-stretchable strings (32) and said rotary encoders are configured to output rotational values proportional to said shifting when said input rotatable shafts rotate, where said shifting length and shifting orientation of each one of said beacon devices (16) is determined as a function of said rotary encoder (18) configuration and said rotational values.

6. The apparatus as claimed in claim 5 further comprising a central communication unit and communication means connected to said beacon devices (16) and to said central communication unit, where said central communication unit receives said rotational values from said beacon devices, maps each rotational value among said rotational values with a corresponding rotary encoder among said rotary encoders (18) by which it was generated, and remotely transmits said mapped rotational values to said processing unit.

7. The apparatus as claimed in claim 6, wherein said processing unit is part of a remote computer system, said central communication unit further comprising a network interface adapted to be connected to a data network for remotely transmitting said mapped rotational values to said processing unit.

8. The apparatus as claimed in claim 6 or 7, wherein said beacon devices (16) comprise storage means for storing said rotational values, wherein said communication means are connected to said storage means for retrieving said rotational values.

9. The apparatus as claimed in any of the preceding claims, wherein said beacon devices (16) are disposed on said piece of fabric in a two dimensional array configuration such that each beacon device has a number of adjacent beacon devices located at different directions thereof.

10. The apparatus as claimed in claim 9, wherein each one of said beacon devices (16) comprises a number of rotary encoders equivalent to said number of adjacent beacon devices such that each pair of rotary encoders located within adjacent beacon devices are linked therebetween by a common string extending from their respective spring loaded reels.

11. The apparatus as claimed in any of the claims 1 to 10, wherein said distance measuring means (18) comprise uniquely identified wire loaded reels disposed within at least a part of said uniquely identified beacon devices (16) in accordance with a reel configuration known a priori, wherein said wire loaded reels store electrical wires having a first end folded within said wire loaded reels and a second end extending therefrom and attached to attach points located at selected directions in accordance with said

reel configuration, such that when said beacon devices (16) shift position, said electrical wires unfold and extend in length proportionally to said shifting.

12. The apparatus as claimed in claim 11, wherein said distance measuring means (18) further comprise electrical means for measuring electrical properties of said wires when unfolded by effect of said shifting, said electrical properties varying as a function of lengths of said wires, where said shifting length and shifting orientation of each one of said beacon devices (16) is determined as a function of said reel configuration and said measured electrical properties.

13. The apparatus as claimed in claim 12, wherein said electrical properties consist of electrical resistances or conductances of said wires.

14. The apparatus as claimed in claim 13 further comprising a central communication unit and communication means connected to said beacon devices (16) and to said central communication unit, where said central communication unit receives said measured electrical properties from said beacon devices, maps each measured electrical property among said measured electrical properties with a corresponding wire reel among said wire reels associated therewith, and remotely transmits said mapped measured electrical properties to said processing unit.

Patentansprüche

1. Vorrichtung (10) zur Verwendung mit einer Verarbeitungseinheit (22) zur Bestimmung einer Abmessung einer ausgewählten Oberfläche eines Objekts, wobei die Vorrichtung umfasst:

ein Messbekleidungsstück (12) mit einer Gestalt, die zu der ausgewählten Oberfläche des Objekts passt, so dass sich das Messbekleidungsstück proportional zu der Abmessung der Oberfläche dehnt, wenn es darüber gelegt wird;
eine Vielzahl von eindeutig identifizierten Markierungseinrichtungen (16), die auf dem Messbekleidungsstück im ungedehnten Zustand entsprechend einer im Voraus bekannten ersten räumlichen Konfiguration angeordnet sind, wobei die Markierungseinrichtungen (16), wenn das Messbekleidungsstück über die Oberfläche gelegt und gedehnt ist, automatisch die Position ändern und als eine Funktion der Abmessung der Fläche eine zweite räumliche Konfiguration bilden; und
elektronische Mittel zum Detektieren der zweiten räumlichen Konfiguration und zum Erzeugen von Daten, die die zweite räumliche Konfiguration repräsentieren, wobei die elektronischen Mittel Entfernungsmessmittel (18) umfassen und wobei die Entfernungsmessmittel (18) mindestens einen Drehgeber (26) mit einer drehbaren Eingangswelle (28) und eine damit gekoppelte federbelastete Spule (30) umfasst,
wobei die federbelastete Spule (30) ein Ende eines nicht dehnbaren Fadens (32) aufnimmt,
wobei jeder Drehgeber (26) an einer Kante einer ersten Markierungseinrichtung (16) angeordnet ist und gestaltet ist, um über den Faden mit einem entsprechenden Drehgeber (26), der an einer Stirnkante einer benachbarten Markierungseinrichtung (16) angeordnet ist, zusammenzuwirken;
wobei die Verarbeitungseinheit (22) konfiguriert ist, um mit den ersten und zweiten räumlichen Konfigurationen verbundene Daten zu empfangen und die Abmessung der Oberfläche als eine Funktion derselben zu bestimmen.

2. Vorrichtung nach Anspruch 1, wobei die Verarbeitungseinheit (22) Teil eines Ferncomputersystems ist, wobei die Vorrichtung ferner Kommunikationsmittel umfasst, die gestaltet sind, um mit einem Datennetzwerk zur Fernübertragung der Daten, die die zweite räumliche Konfiguration repräsentieren, an die Verarbeitungseinheit verbunden zu werden.

3. Vorrichtung nach Anspruch 1, wobei die Entfernungsmessmittel (18) die Bestimmung einer Verschiebungslänge und einer Verschiebungsorientierung von jeder der Markierungseinrichtungen (16), wenn die Markierungseinrichtungen die Position ändern, ermöglichen.

4. Vorrichtung nach Anspruch 3, wobei die Drehgeber eindeutig identifizierte Drehgeber sind, die innerhalb zumindest eines Teils der eindeutig identifizierten Markierungseinrichtungen (16) gemäß einer im Voraus bekannten Drehgeber (18)-Konfiguration angeordnet sind, wobei die Drehgeber drehbare Eingabewellen umfassen, die mit federbelasteten Spulen gekoppelt sind, die Fäden (32) aufnehmen, wobei die Fäden (32) ein erstes Ende, das in den federbelasteten Spulen aufgewickelt ist, und ein zweites Ende, das sich davon erstreckt und an Befestigungspunkten angebracht ist, die in ausgewählten Richtungen gemäß der Drehgeber (18)-Konfiguration angeordnet sind, aufweisen, so dass, wenn die Markierungseinrichtungen (16) ihre Position ändern, die Fäden (32) abgewickelt werden und mit den drehbaren Eingabewellen in Eingriff stehen, um proportional zur Verschiebung zu drehen.

5. Vorrichtung nach Anspruch 4, wobei die nicht dehnbaren Fäden (32) und die Drehgeber konfiguriert sind, um zur Verschiebung proportionale Drehwerte

auszugeben, wenn sich die drehbaren Eingangswellen drehen, wobei die Verschiebungslänge und Verschiebungsorientierung jeder der Markierungseinrichtungen (16) als eine Funktion der Drehgeber (18)-Konfiguration und der Drehwerte bestimmt sind.

6. Vorrichtung nach Anspruch 5, ferner umfassend eine zentrale Kommunikationseinheit und mit den Markierungseinrichtungen (16) und der zentralen Kommunikationseinrichtung verbundene Kommunikationsmittel, wobei die zentrale Kommunikationseinheit die Drehwerte von den Markierungseinrichtungen empfängt, jeden Drehwert der Drehwerte auf einen entsprechenden Drehgeber der Drehgeber (18), durch den er erzeugt wurde, abbildet und die abgebildeten Drehwerte zur Verarbeitungseinheit fernüberträgt.

7. Vorrichtung nach Anspruch 6, wobei die Verarbeitungseinheit Teil eines Ferncomputersystems ist, die zentrale Kommunikationseinheit ferner eine Netzwerkschnittstelle umfasst, die gestaltet ist, um mit einem Datennetzwerk für Fernübertragung der abgebildeten Rotationswerte zur Verarbeitungseinheit verbunden zu werden.

8. Vorrichtung nach Anspruch 6 oder 7, wobei die Markierungseinrichtungen (16) Speichermittel zum Speichern der Drehwerte umfassen, wobei die Kommunikationsmittel mit den Speichermitteln zum Erfassen der Drehwerte verbunden sind.

9. Vorrichtung nach einem der vorangehenden Ansprüche, wobei die Markierungseinrichtungen (16) auf dem Stück Stoff in einer zweidimensionalen Array-Konfiguration angeordnet sind, so dass jede Markierungseinrichtung eine Anzahl von benachbarten Markierungseinrichtungen aufweist, die in unterschiedlichen Richtungen derselben angeordnet sind.

10. Vorrichtung nach Anspruch 9, wobei jede der Markierungseinrichtungen (16) eine Anzahl von Drehgebern entsprechend der Anzahl von benachbarten Markierungseinrichtungen umfasst, so dass jedes Paar von Drehgebern, die in benachbarten Markierungseinrichtungen angeordnet sind, dazwischen durch einen gemeinsamen Faden verbunden sind, der sich von deren jeweiligen federbelasteten Spulen erstreckt.

11. Vorrichtung nach einem der Ansprüche 1 bis 10, wobei die Entfernungsmessmittel (18) eindeutig identifizierte drahtbelastete Spulen umfassen, die in zumindest einem Teil der eindeutig identifizierten Markierungseinrichtungen (16) in einer im voraus bekannten Spulenkonfiguration angeordnet sind, wobei die drahtbelasteten Spulen elektrische Drähte mit einem ersten Ende, das in den drahtbelasteten Spulen aufgewickelt ist, und einem zweiten Ende, das sich davon erstreckt und an Befestigungspunkten angebracht ist, die sich in ausgewählten Richtungen gemäß der Spulenkonfiguration befinden, aufnehmen, so dass, wenn die Markierungseinrichtungen (16) die Position ändern, die elektrischen Drähte abgewickelt werden und sich hinsichtlich der Länge proportional zur Verschiebung erstrecken.

12. Vorrichtung nach Anspruch 11, wobei die Entfernungsmessmittel (18) ferner elektrische Mittel zur Messung von elektrischen Eigenschaften der Drähte bei Abwicklung durch die Verschiebung umfassen, wobei die elektrischen Eigenschaften als eine Funktion von Längen der Drähte variieren, wobei die Verschiebungslänge und Verschiebungsorientierung von jeder der Markierungseinrichtungen (16) als eine Funktion der Spulenkonfiguration und der gemessenen elektrischen Eigenschaften bestimmt ist.

13. Vorrichtung nach Anspruch 12, wobei die elektrischen Eigenschaften aus elektrischen Widerständen oder Leitfähigkeiten der Drähte bestehen.

14. Vorrichtung nach Anspruch 13, ferner umfassend eine zentrale Kommunikationseinheit und mit den Markierungseinrichtungen (16) und der zentralen Kommunikationseinheit verbundene Kommunikationsmittel, wobei die zentrale Kommunikationseinheit die gemessenen elektrischen Eigenschaften von den Markierungseinrichtungen empfängt, jede gemessene elektrische Eigenschaft der gemessenen elektrischen Eigenschaften auf eine entsprechende Drahtspule der verbundenen Drahtspulen abbildet und die abgebildeten gemessenen elektrischen Eigenschaften zur Verarbeitungseinheit fernüberträgt.

Revendications

1. Appareil (10) configuré pour être utilisé avec une unité de traitement (22) afin de déterminer la dimension d'une surface sélectionnée d'un objet, ledit appareil comprenant :

un vêtement de mesure (12) ayant une forme adaptée pour s'ajuster à ladite surface sélectionnée dudit objet de sorte que ledit vêtement de mesure s'étire proportionnellement à ladite dimension de ladite surface lorsqu'il est drapé sur celle-ci ;
une pluralité de dispositifs de balise identifiés de façon unique (16) disposés sur ledit vêtement de mesure lorsqu'il n'est pas étiré conformément à une première configuration spatiale con-

nue a priori, où, lorsque ledit vêtement de mesure est drapé sur ladite surface et étiré par celle-ci, lesdits dispositifs de balise (16) changent automatiquement de position et forment une deuxième configuration spatiale en fonction de ladite dimension de ladite surface ; et
un moyen électronique pour détecter ladite deuxième configuration spatiale et pour générer des données représentant ladite deuxième configuration spatiale, où ledit moyen électronique comprend un moyen de mesure de distance (18) et où le moyen de mesure de distance (18) comprend au moins un codeur rotatif (26) ayant un arbre rotatif d'entrée (28) et une bobine à ressort (30) qui lui est couplée, où la bobine à ressort (30) stocke une extrémité d'une chaîne non étirable (32), où chaque codeur rotatif (26) est disposé sur un bord d'un premier dispositif de balise (16) et est adapté, par l'intermédiaire de la chaîne, pour être en relation de coopération avec un codeur rotatif correspondant (26) disposé sur un bord opposé d'un dispositif de balise adjacent (16) ;
où ladite unité de traitement (22) est configurée pour recevoir des données associées auxdites première et deuxième configurations spatiales et pour déterminer ladite dimension de ladite surface en fonction de celles-ci.

2. Appareil tel que revendiqué dans la revendication 1, dans lequel ladite unité de traitement (22) fait partie d'un système informatique distant, ledit appareil comprenant en outre un moyen de communication adapté pour être connecté à un réseau de données pour transmettre à distance lesdites données représentant ladite deuxième configuration spatiale à ladite unité de traitement.

3. Appareil tel que revendiqué dans la revendication 1, dans lequel ledit moyen de mesure de distance (18) permet de déterminer une longueur de décalage et une orientation de décalage de chacun desdits dispositifs de balise (16) lorsque lesdits dispositifs de balise changent de position.

4. Appareil tel que revendiqué dans la revendication 3, dans lequel lesdits codeurs rotatifs sont des codeurs rotatifs identifiés de façon unique disposés dans au moins une partie desdits dispositifs de balise identifiés de façon unique (16) conformément à une configuration de codeur rotatif (18) connue a priori, où lesdits codeurs rotatifs comprennent des arbres rotatifs d'entrée couplés à des bobines à ressort stockant des chaînes (32), où lesdites chaînes (32) ont une première extrémité pliée dans lesdites bobines à ressort et une deuxième extrémité s'étendant à partir de celles-ci et fixée à des points de fixation situés à des directions sélectionnées conformément à ladite configuration de codeur rotatif (18), de sorte que lorsque lesdits dispositifs de balise (16) changent de position, lesdites chaînes (32) se déploient et s'engagent avec lesdits arbres rotatifs d'entrée pour tourner proportionnellement audit changement.

5. Appareil tel que revendiqué dans la revendication 4, dans lequel lesdites chaînes non étirables (32) et lesdits codeurs rotatifs sont configurés pour délivrer en sortie des valeurs de rotation proportionnelles audit changement lorsque lesdits arbres rotatifs d'entrée tournent, où ladite longueur de changement et ladite orientation de changement de chacun desdits dispositifs de balise (16) est déterminée en fonction de ladite configuration de codeur rotatif (18) et desdites valeurs de rotation.

6. Appareil tel que revendiqué dans la revendication 5 comprenant en outre une unité de communication centrale et un moyen de communication connecté auxdits dispositifs de balise (16) et à ladite unité de communication centrale, où ladite unité de communication centrale reçoit lesdites valeurs de rotation à partir desdits dispositifs de balise, mappe chaque valeur de rotation parmi lesdites valeurs de rotation avec un codeur rotatif correspondant parmi lesdits codeurs rotatifs (18) par lequel elle a été générée, et transmet à distance lesdites valeurs de rotation mappées à ladite unité de traitement.

7. Appareil tel que revendiqué dans la revendication 6, dans lequel ladite unité de traitement fait partie d'un système informatique distant, ladite unité de communication centrale comprenant en outre une interface de réseau adaptée pour être connectée à un réseau de données pour transmettre à distance lesdites valeurs de rotation mappées à ladite unité de traitement.

8. Appareil tel que revendiqué dans la revendication 6 ou 7, dans lequel lesdits dispositifs de balise (16) comprennent un moyen de stockage pour stocker lesdites valeurs de rotation, où ledit moyen de communication est connecté audit moyen de stockage pour extraire lesdites valeurs de rotation.

9. Appareil tel que revendiqué dans l'une des revendications précédentes, dans lequel lesdits dispositifs de balise (16) sont disposés sur ladite pièce de tissu dans une configuration de réseau bidimensionnel, de sorte que chaque dispositif de balise ait un nombre de dispositifs de balise adjacents situés à différentes directions de celui-ci.

10. Appareil tel que revendiqué dans la revendication 9, dans lequel chacun desdits dispositifs de balise (16) comprend un nombre de codeurs rotatifs équivalent audit nombre de dispositifs de balise adjacents de

sorte que chaque paire de codeurs rotatifs situés dans des dispositifs de balise adjacents soient reliés entre eux par une chaîne commune s'étendant à partir de leurs bobines à ressort respectives.

11. Appareil tel que revendiqué dans l'une des revendications 1 à 10, dans lequel ledit moyen de mesure de distance (18) comprend des dévidoirs de fil identifiés de façon unique disposés dans au moins une partie desdits dispositifs de balise identifiés de façon unique (16) conformément à une configuration de dévidoir connue a priori, où lesdits dévidoirs de fil stockent des fils électriques ayant une première extrémité pliée dans lesdits dévidoirs de fil et une deuxième extrémité s'étendant à partir de ceux-ci et fixée à des points de fixation situés à des directions sélectionnées conformément à ladite configuration de dévidoir, de sorte que lorsque lesdits dispositifs de balises (16) changent de position, lesdits fils électriques se déploient et s'étendent en longueur proportionnellement audit changement.

12. Appareil tel que revendiqué dans la revendication 11, dans lequel ledit moyen de mesure de distance (18) comprend en outre un moyen électrique destiné à mesurer les propriétés électriques desdits fils lorsqu'ils sont déployés sous l'effet dudit changement, lesdites propriétés électriques variant en fonction des longueurs desdits fils, où ladite longueur de changement et ladite orientation de changement de chacun desdits dispositifs de balise (16) est déterminée en fonction de ladite configuration de dévidoir et desdites propriétés électriques mesurées.

13. Appareil tel que revendiqué dans la revendication 12, dans lequel lesdites propriétés électriques sont constituées des résistances électriques ou des conductances desdits fils.

14. Appareil tel que revendiqué dans la revendication 13 comprenant en outre une unité de communication centrale et un moyen de communication connecté auxdits dispositifs de balise (16) et à ladite unité de communication centrale, où ladite unité de communication centrale reçoit lesdites propriétés électriques mesurées à partir desdits dispositifs de balise, mappe chaque propriété électrique mesurée parmi lesdites propriétés électriques mesurées avec un dévidoir de fil correspondant parmi lesdits dévidoirs de fil qui leur sont associés, et transmet à distance lesdites propriétés électriques mesurées mappées à ladite unité de traitement.

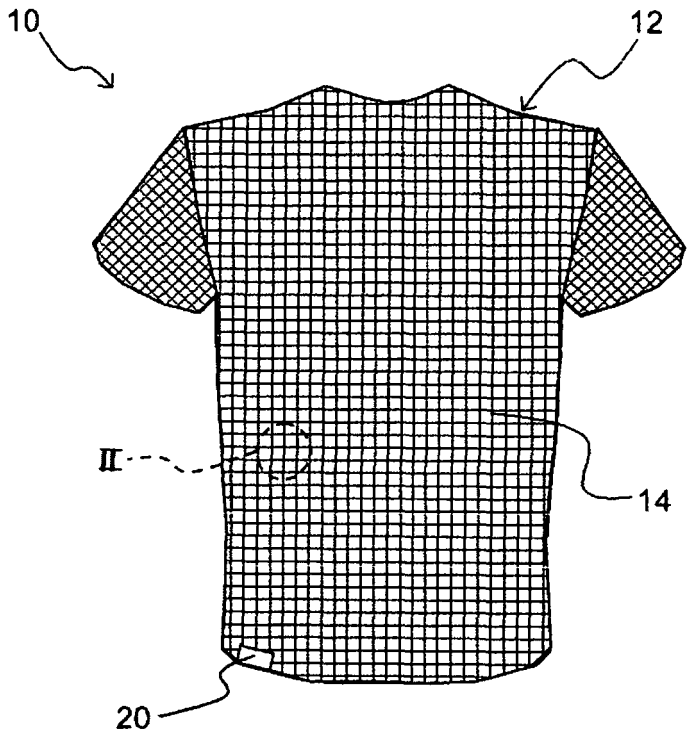

FIGURE 1

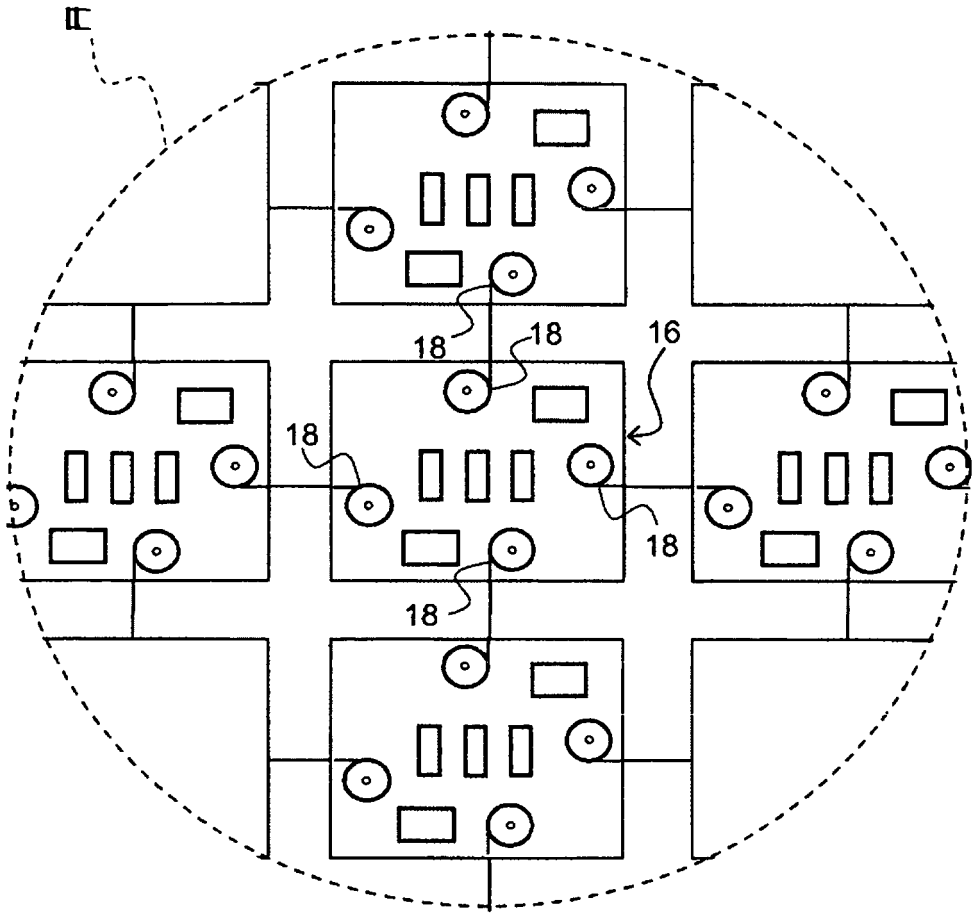

FIGURE 2

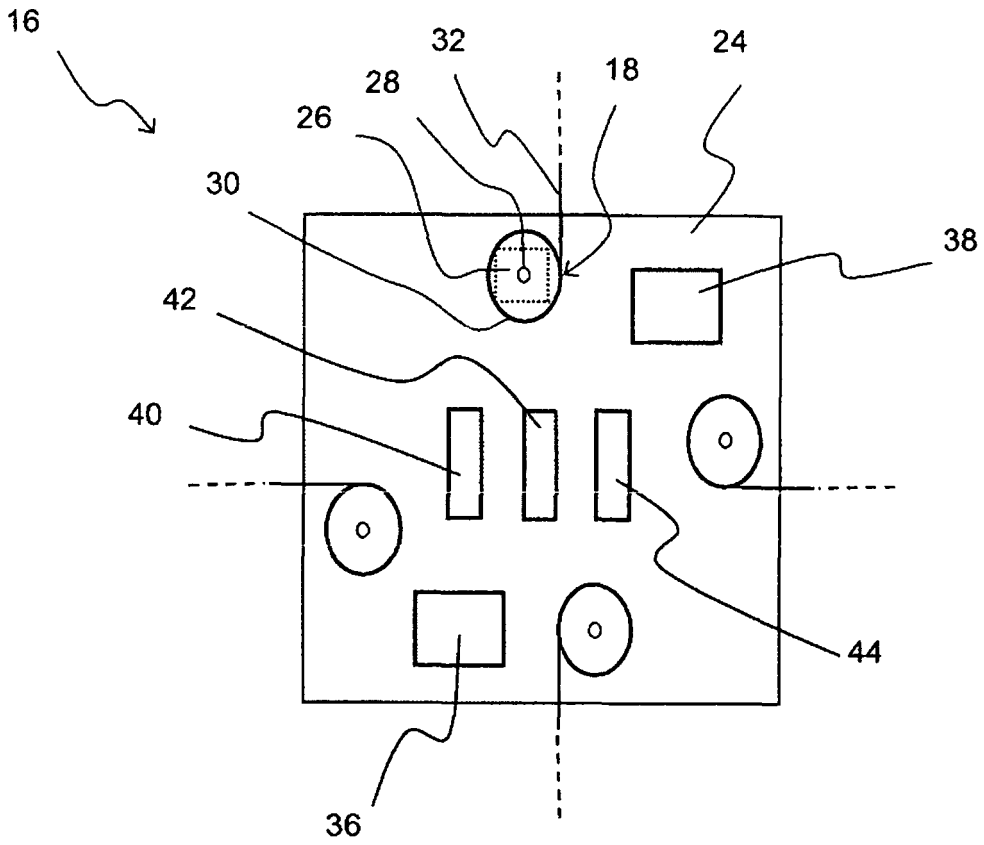

FIGURE 3

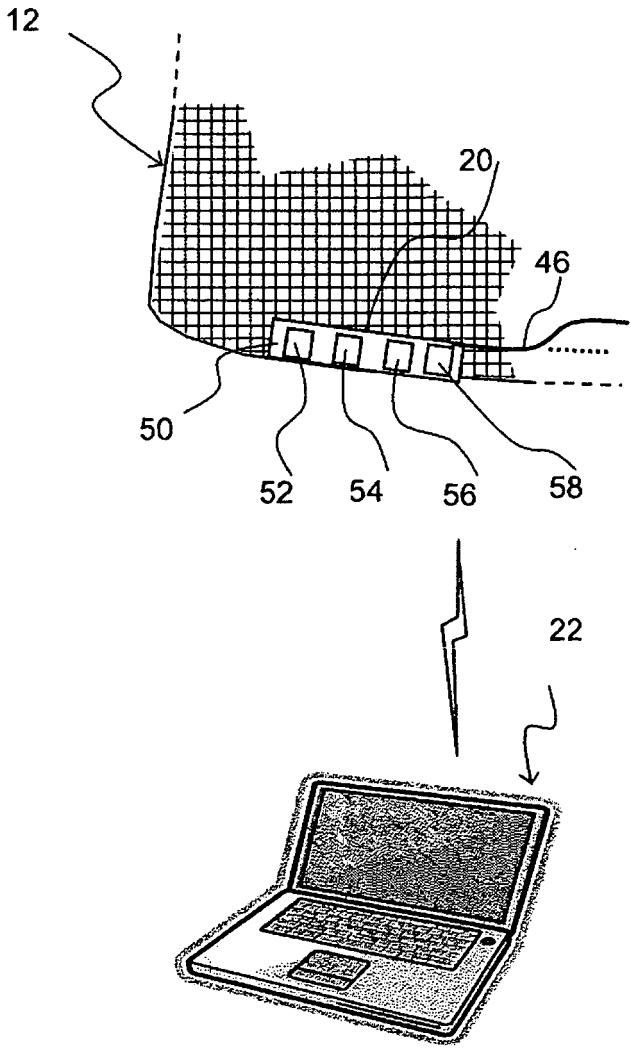

FIGURE 4

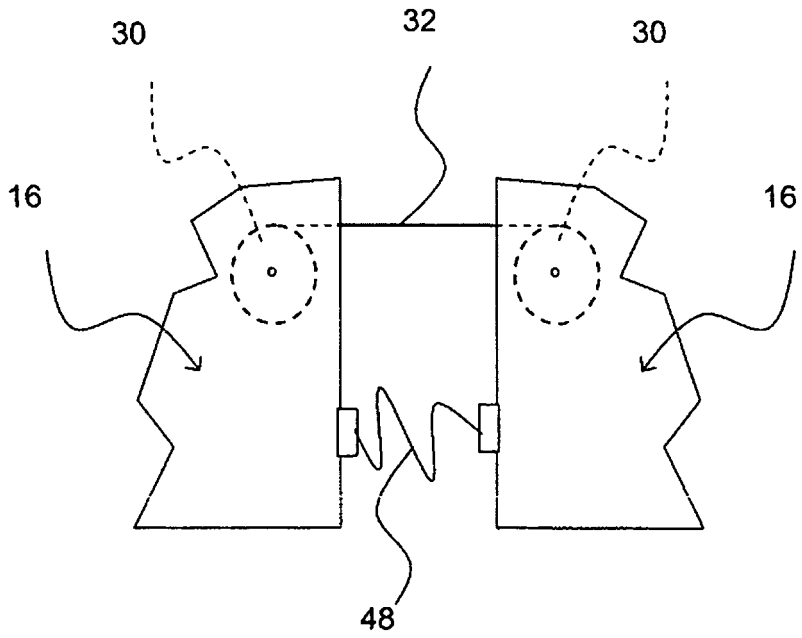

FIGURE 5

REFERENCES CITED IN THE DESCRIPTION

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