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(54) **CONTACTLESS MEASUREMENT, MONITORING AND COMMUNICATION OF BODILY FUNCTIONS OF INFANTS AND OTHER HELPLESS INDIVIDUALS**

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(52) **U.S. Cl.**

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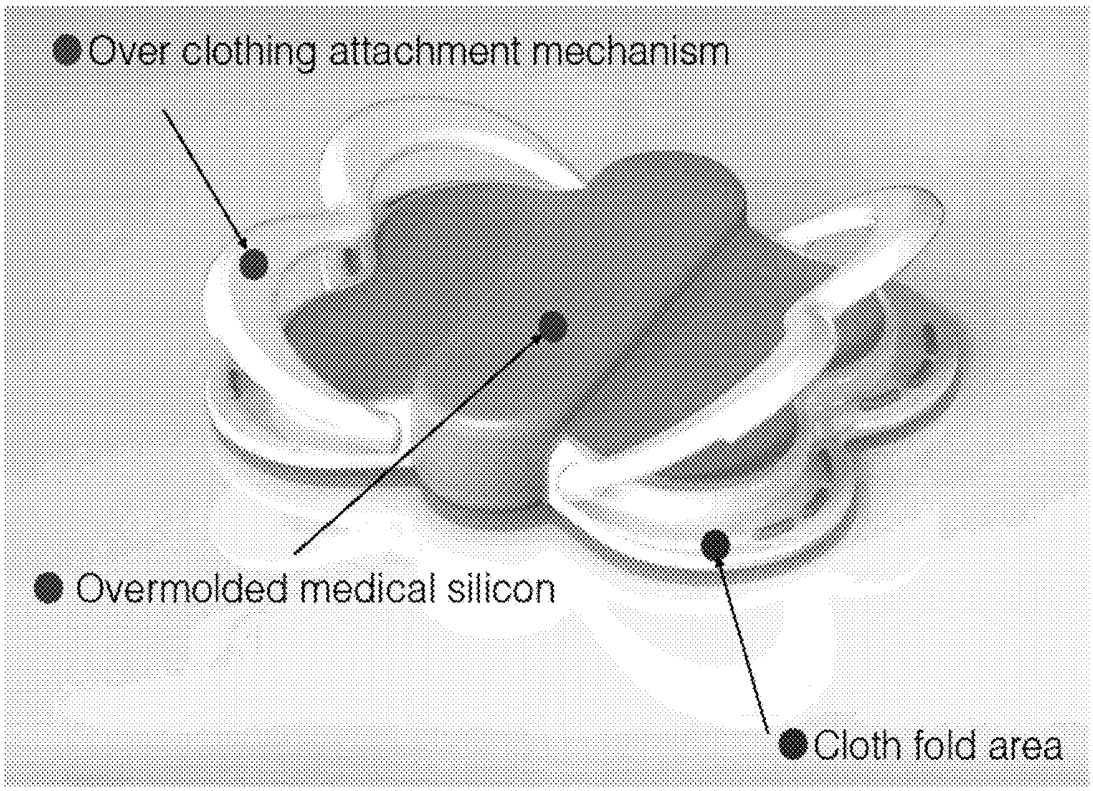
(57) **ABSTRACT**

A method and system for contactless detection and measurement of a variety of bodily functions and environmental conditions of and in the presence of an infant or other helpless individual, and for communication of measured data to a remote user and/or recording and/or interpreting apparatus.

An apparatus that includes said detection, measurement, and communication means mounted within a small, attractive, and intrinsically safe enclosure that attaches to the clothing of the individual.



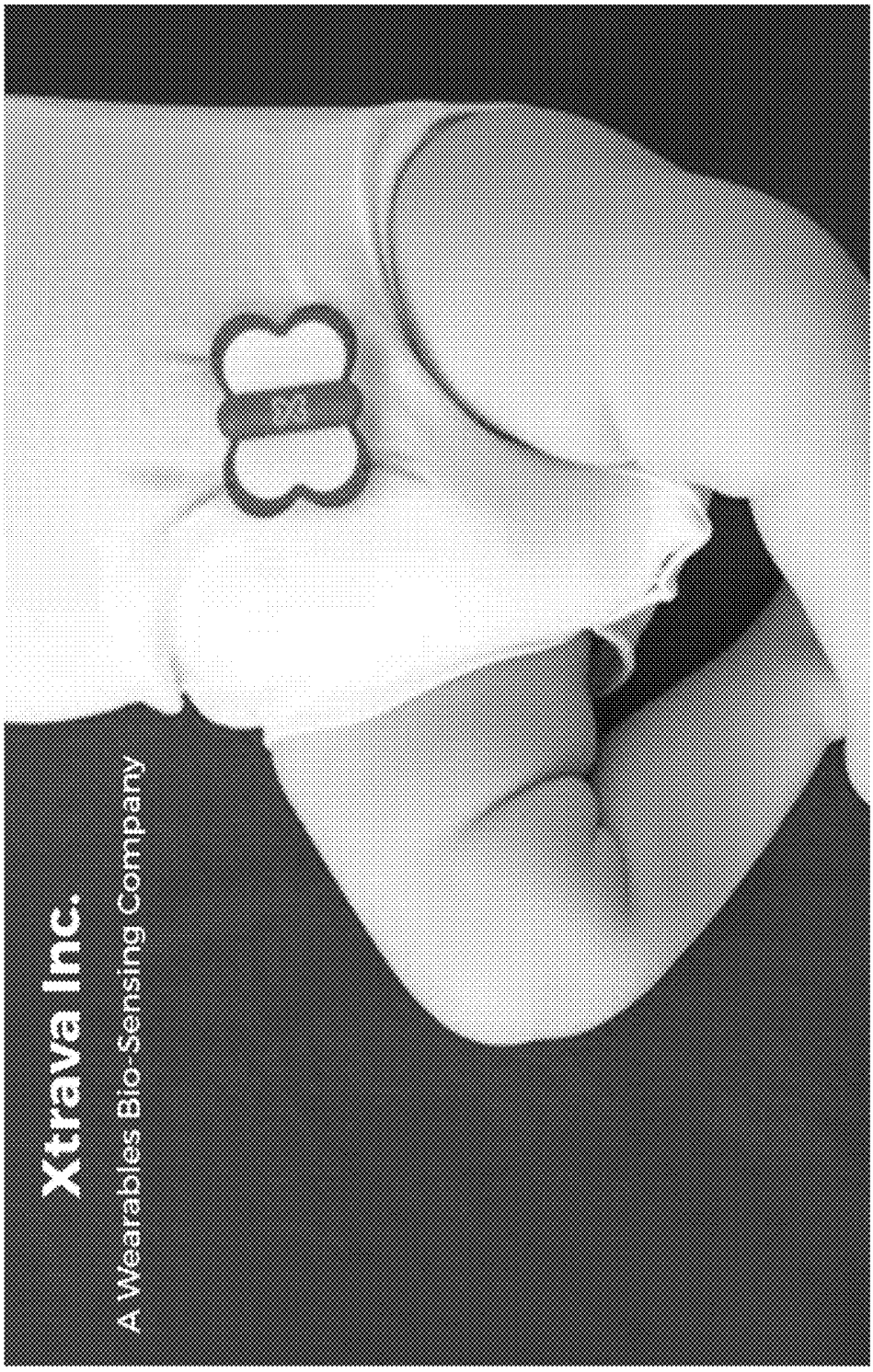


FIG. 1

Reading & Engaging
Was she read to at daycare today?
Emotions & Behavior
Did she get angry at babysitter?
Diet & Habits
Is it time to feed?
Did she have her lunch at daycare?
Health & Safety
Are his breathing & pulse normal?
Is he warm?
Diaper & Hygiene
Is his diaper wet?
How many diaper changes today?
Rest & Activity
Which position is he in?
When is he going to wake up?

FIG. 2

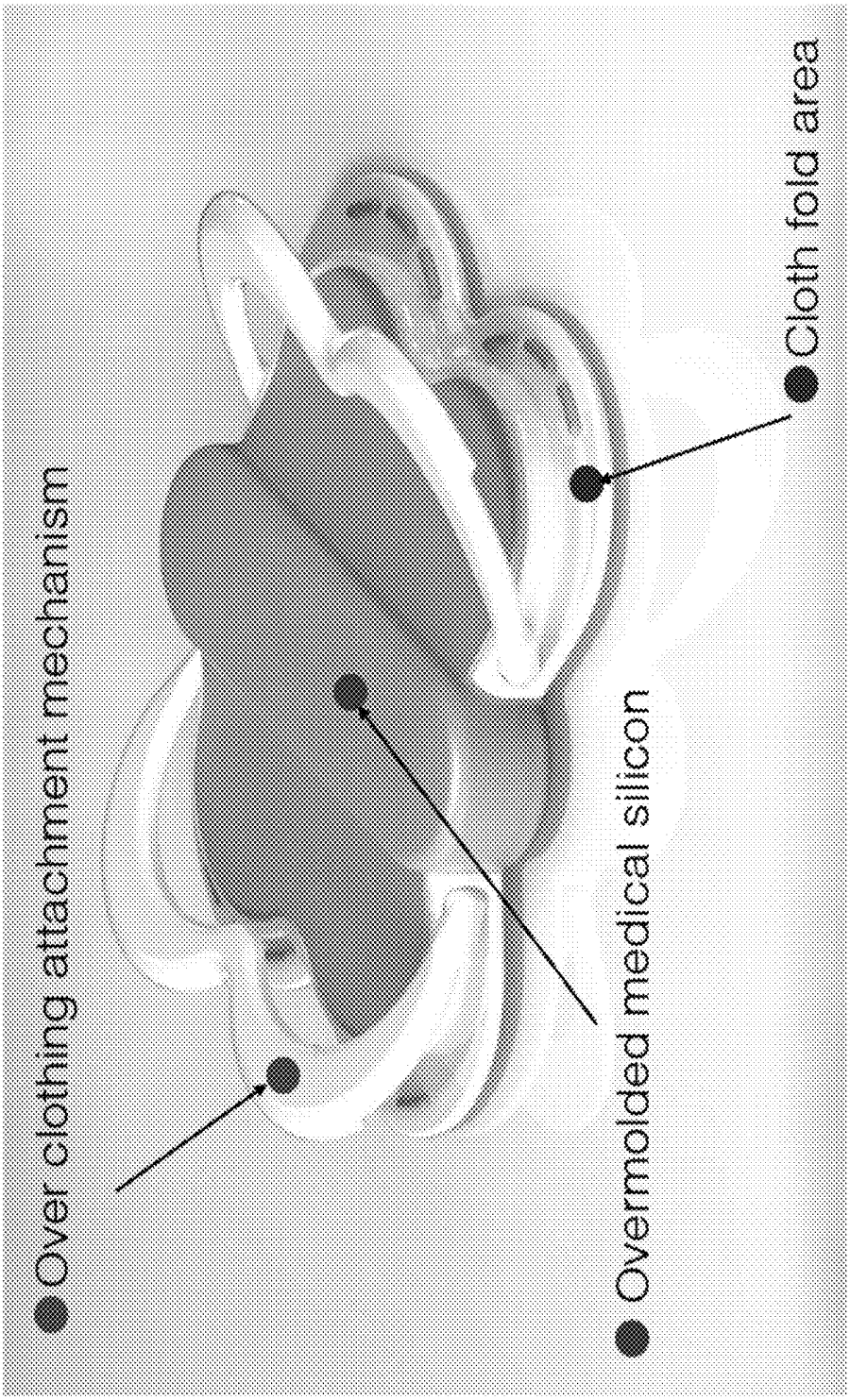

Over clothing attachment mechanism
Overmolded medical silicon
Cloth fold area

FIG. 3

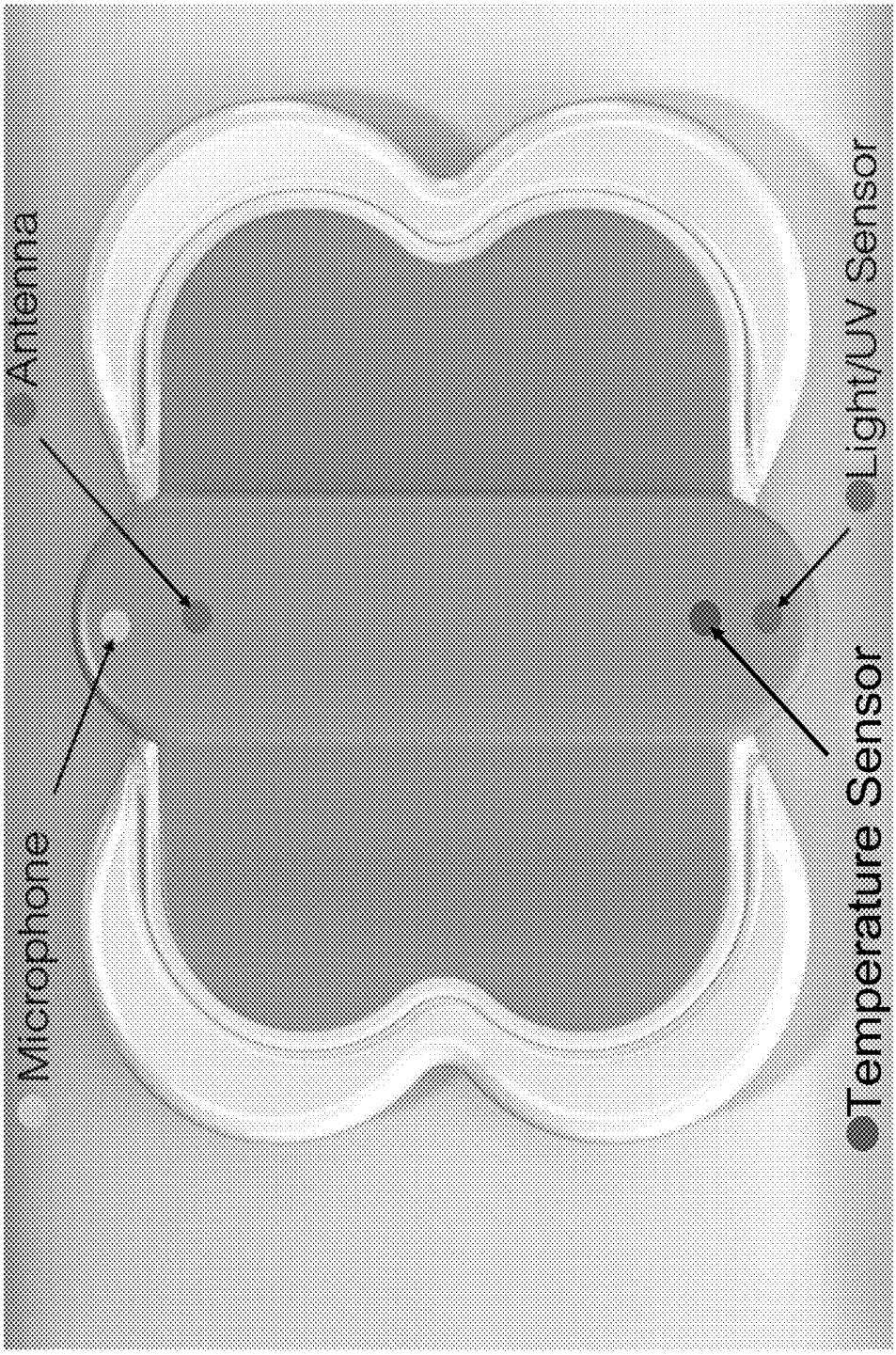


FIG. 4

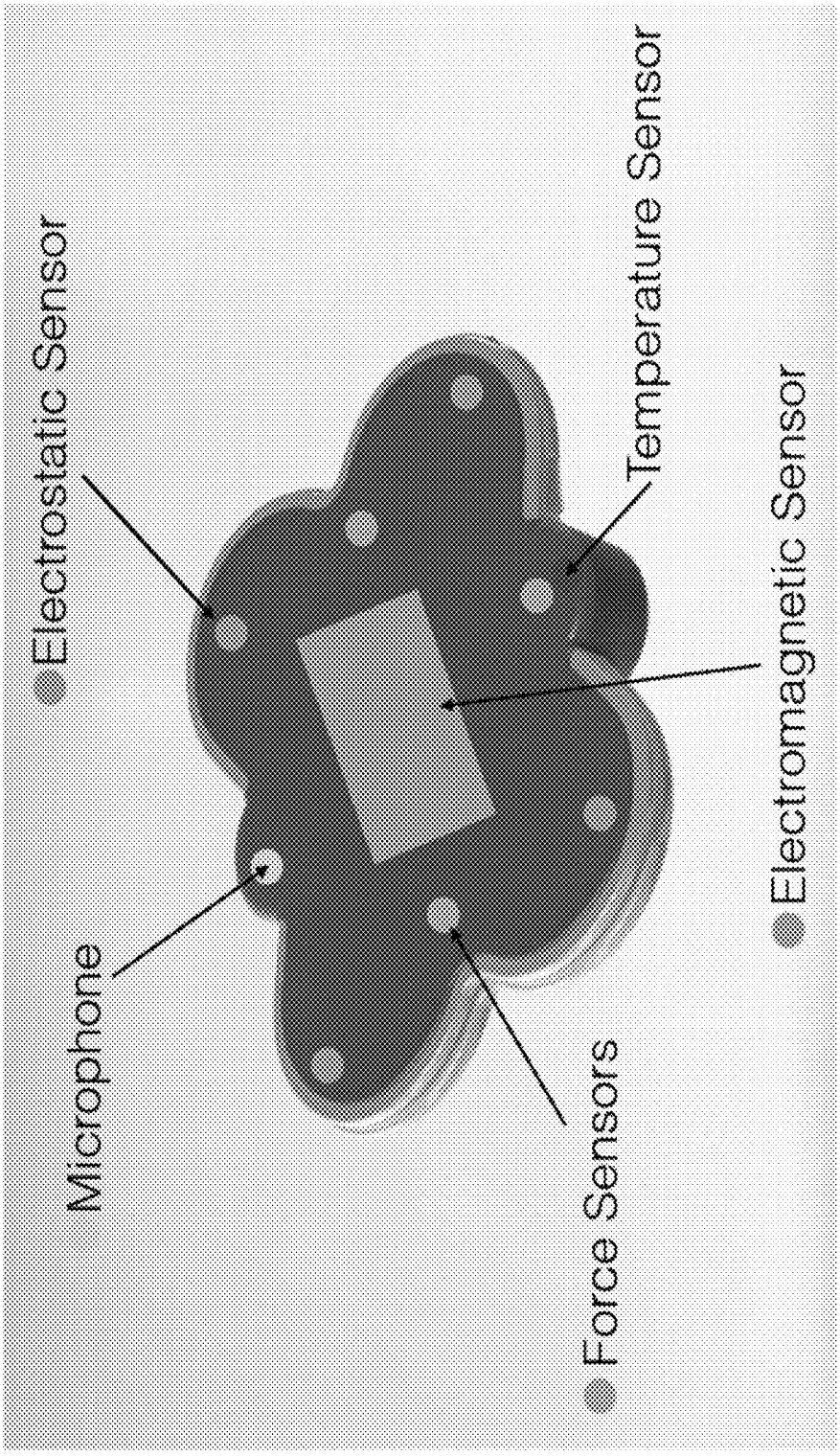

Electrostatic Sensor
Temperature Sensor
Microphone
Electromagnetic Sensor
Force Sensors

FIG. 5

CONTACTLESS MEASUREMENT, MONITORING AND COMMUNICATION OF BODILY FUNCTIONS OF INFANTS AND OTHER HELPLESS INDIVIDUALS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] Priority is claimed under 37 CFR 1.78 and 35 USC 119(e) to U.S. Provisional Application 62/306,463 (XT1603101), filed 10 Mar. 2016), which is incorporated by reference.

TECHNICAL FIELD

[0002] This disclosure relates generally to wearable electronic measurement, monitoring, and communication equipment. More specifically, this disclosure relates to wearable electronic measurement, monitoring and automated communication equipment for infants, babies, children, and adults who cannot adequately care for themselves.

BACKGROUND

[0003] During the past several years, there have been many products introduced to allow monitoring of infants and others for reasons of safety. Parents and others are able to monitor subjects who are located in different rooms of a dwelling or in completely different locations. Wired intercom systems that existed more than 60 years ago have been replaced by or supplemented with handy wireless equipment. More recently, communication for monitoring purposes has been supplemented with remote monitoring of bodily functions such as breathing and heart rate. Remote vital sign monitoring of cardiac and other patients by professional organizations has been supplemented with low cost equipment for consumers.

BRIEF SUMMARY

[0004] This Brief Summary is provided as a general introduction to the Disclosure provided by the Detailed Description and Figures, summarizing some aspects of the disclosed invention. It is not a detailed overview of the Disclosure, and should not be interpreted as necessarily identifying key elements of the invention, or otherwise characterizing the scope of the invention disclosed in this Patent Document.

[0005] This disclosure covers novel ideas to expand upon existing equipment that measures and remotely monitors bodily functions. Additional ideas, when implemented, cause the monitoring equipment and systems to be more practical. For instance, the apparatus described here to measure and communicate life signs and other functions of infants is not attached directly to or in contact with the subject, but rather, to the outside of his clothing. Novel scientific methods, used singly and in combination, make this contactless improvement possible.

[0006] The specific apparatus, mainly for infants, is contained in an intrinsically safe and attractive enclosure. The enclosure shape is not only attractive, but can facilitate measurements and communication. Multiple quantities and types of sensors "Distributed Sensing" provide redundancy and reliability of bodily function measurements and facilitate removing the need for direct bodily contact.

[0007] Bodily functions that could be measured, monitored, and communicated in real time include temperature, heart rate, electrocardiogram, blood glucose concentration, breathing rate, coughing, sneezing, wheezing, gagging, edema, obstructed airway, reflux, regurgitation, vomiting, miscellaneous motion, position, water retention, bladder abundance, clothing wetness, stomach abundance, sleep patterns, and sounds. Environment measurements include sounds, temperature, and light, including UV. Apparatus to implement these measurements and communication to the user could include multiple 3-axis accelerometers, magnetic eddy current sensors, multiple electrostatic sensing elements, microphones, temperature, light/UV sensors, and RF Wireless. Interpretation of raw data is implemented with the aid of advanced automated machine learning techniques. Machine learning and other calculation tasks could be distributed among the apparatus attached to the Subject's clothing and other system building blocks, such as local video and communication devices and even the user's smart phone.

[0008] Other aspects, features and advantages of the invention will be apparent to those skilled in the art from the following Disclosure.

BRIEF DESCRIPTION OF DRAWINGS

[0009] For a more complete understanding of this disclosure and its features, reference is now made to the following description, taken in conjunction with the accompanying drawings, in which:

[0010] FIG. **1** shows an example instrument apparatus attached to the outside of a diaper being worn by an infant.

[0011] FIG. **2** shows examples of information about said infant that could be measured by the instrument shown in FIG. **1** and communicated locally and thence world-wide.

[0012] FIG. **3** shows details of an example mechanism to safely attach said instrument to the outside of clothing.

[0013] FIG. **4** shows the side of said instrument that faces away from said infant, with the mounting rails closed and without being attached to clothing. Also shown are possible locations of various sensors and RF communications antenna.

[0014] FIG. **5** shows the side of said instrument that faces toward said infant, showing possible locations of various sensors that gather information about him/her.

DETAILED DESCRIPTION

[0015] The various figures, discussed below, and the various embodiments used to describe the principles of the present invention in this patent document are by way of illustration only and should not be construed in any way to limit the scope of the invention. Those skilled in the art will understand that the principles of the invention may be implemented in any type of suitably arranged device or system. For instance, although the figures show the instrument enclosure with a shape that could be construed to resemble a butterfly or other winged creature, the enclosure can have a side variety of shapes. The attachment mechanism shown and later described is but one example of a safe means to attach the instrument to clothing.

[0016] In general, this disclosure describes apparatus that attaches to the clothing of the subject being monitored ("Subject"), obtains real time information pertaining to a significant variety of bodily functions and environmental conditions, and communicates said information immediately

to interested parties and/or recording equipment ("User") who may be co-located or at any remote location.

[0017] Depending upon the implementation, this technique can provide significant benefits in a range of fields, such as care for infants, small children, elderly, the mentally challenged, ill and injured, and others who cannot fully care for themselves.

[0018] FIG. **1** shows the example instrument apparatus attached to a diaper worn by an infant. This instrument could also be attached to clothing worn by a baby, a child, an adult, or even an animal. Although it looks like a decoration or toy (in this example resembling a butterfly or other small winged creature) and is as safe as a properly designed toy, it is loaded with technology that communicates with the outside world and assesses a host of bodily functions and environmental conditions. Safety features include but are not limited to enclosure materials used in toys, the lack of sharp corners, a size that is too large for a baby to swallow, and an ultra-safe level of emissions.

[0019] FIG. **2** illustrates an example User interface employing a smart phone, and the Subject sensor apparatus itself. It also shows a partial list of service functions performed with the aid of the apparatus.

[0020] FIG. **3** shows the instrument apparatus sensors, measuring instrument and communication apparatus as seen from the side that faces away from the Subject. The overall size is large enough that it cannot be swallowed by a baby or small child. The material composition is a "medical" Silicon that is used for teething toys. The clothing cloth fits into the fold region at the edges of the "wings", and the attachment mechanisms, shown in the open state, clamps the clothing or diaper.

[0021] FIG. **4** also shows the Subject instrument sensor, measuring instrument and communication apparatus as seen from the side that faces away from the Subject. The attachment mechanism is shown in the closed condition. Also shown is the region where the RF communications antenna and various example facilities may be located inside the enclosure. The Light/UV sensor is located at one end of the instrument, as an indicator of normal ambient light on the Subject, as well as damaging ultra-violet radiation. An additional sensor for infrared radiation could also be added. At the other end of the instrument is the microphone that monitors ambient sounds of the subject and others. Next to the light/UV sensor is an ambient temperature measurement sensor. For the light, temperature, and sound sensors, the Silicon enclosure has modified properties to pass light and sound and temperature information but still maintain integrity such as waterproofing and safety.

[0022] FIG. **5** shows the side of the Subject instrument and communication apparatus that faces the Subject. The microphone on this side picks up internal sounds from the Subject's body, and the temperature sensor picks up internal "core" body temperature. The electromagnetic and electrostatic sensors could pick up motion and properties of internal organs and fluids. The items marked "force sensors" are 3-axis accelerometers that also help determine motion of internal organs, but mainly sense motion and position of the body as a whole.

[0023] The different types of sensors, and multiple sets of sensors of the same type provide measurements of many bodily functions as well as additional accuracy, redundancy and reliability of said measurements.

[0024] The sensors and communication devices located within this Subject instrument apparatus emit fields that are intrinsically safe as defined by recognized safety standards. Emissions from the instrument that permeate the Subject's body are several orders of magnitude smaller than the minimum recommended by the Federal Communications Commission and other widely recognized standards and regulatory institutions and agencies.

[0025] Other embodiments could be implemented in any other suitable manner. For example, other enclosure materials than that mentioned in this disclosure may have all the desired properties to be safe for babies. The apparatus may have different sizes, shapes, and fastening mechanisms, and may be placed in different positions on the body. The clothing could be a diaper as shown or any other type or style. The Subject could be an infant, any other variety of human, or non-human.

[0026] The details provided in the foregoing description and figures describe in part particular implementations of the systems for performing the functions explained in this disclosure. Other embodiments could be implemented in any other suitable manner. For example, the figures show a particular module physical size and other physical configurations. This disclosure and as-built example equipment report on and utilize a standard interface package—the size, as opposed to other sizes and shapes. These configurations are for illustration only. Other embodiments could use different key system blocks, depending upon the implementation. Moreover, measuring pulse and respiration rate within the body only two examples of what the methods of this disclosure can perform. Other embodiments could be implemented in any other suitable manner. For example, this disclosure describes particular sizes, shapes, and other values. These values are for illustration only.

[0027] It may be advantageous to set forth definitions of certain words and phrases used throughout this patent document. The term "couple" and its derivatives refer to any direct or indirect communication between two or more elements, whether or not those elements are in physical contact with one another. The terms "transmit," "receive," and "communicate," as well as derivatives thereof, encompass both direct and indirect communication. The terms "include" and "comprise," as well as derivatives thereof, mean inclusion without limitation. The term "or" is inclusive, meaning and/or. The phrases "associated with" and "associated therewith," as well as derivatives thereof, may mean to include, be included within, interconnect with, contain, be contained within, connect to or with, couple to or with, be communicable with, cooperate with, interleave, juxtapose, be proximate to, be bound to or with, have, have a property of, have a relationship to or with, or the like.

[0028] While this disclosure has described certain embodiments and generally associated methods, alterations and permutations of these embodiments and methods will be apparent to those skilled in the art. Accordingly, the above description of example embodiments does not define or constrain this disclosure. Other changes, substitutions, and alterations are also possible without departing from the spirit and scope of this disclosure, as defined by the following claims.

What is claimed is:

1. A system that permits the continuous or intermittent non-invasive measurement and wireless reporting of internal bodily functions of a subject, who can be a human or other animal, that consists of

a compact, light-weight, unobtrusive and very low power-consuming instrument apparatus that contains sensors and wireless communication circuitry, attaches to clothing and requires no direct contact with the body;

Firmware and/or software to facilitate intermittent or real time communication and analysis of the data from said instrument apparatus.

2. A system that permits the continuous or intermittent non-invasive measurement and wireless reporting of internal bodily functions of a subject, including vital signs, of a subject, who can be a human or other animal, that consists of

a compact, light-weight, unobtrusive and very low power-consuming instrument apparatus that contains sensors and wireless communication circuitry, attaches to clothing and requires no direct contact with the body;

Firmware and/or software to facilitate intermittent or real time communication and analysis of the data from said instrument apparatus.

3. A system that permits the continuous or intermittent non-invasive measurement and wireless reporting of internal bodily functions and/or conditions in the immediate vicinity of a subject, who can be a human or other animal, that consists of

a compact, light-weight, unobtrusive and very low power-consuming instrument apparatus that contains sensors and wireless communication circuitry, attaches to clothing and requires no direct contact with the body;

Firmware and/or software to facilitate intermittent or real time communication and analysis of the data from said instrument apparatus.

4. A system that permits the continuous or intermittent non-invasive measurement and wireless reporting of internal bodily functions, body position and motion, of a subject who can be a human or other animal, that consists of

a compact, light-weight, unobtrusive and very low power-consuming instrument apparatus that contains sensors and wireless communication circuitry, attaches to clothing and requires no direct contact with the body;

Firmware and/or software to facilitate intermittent or real time communication and analysis of the data from said instrument apparatus.

5. A system that permits the continuous or intermittent non-invasive measurement and wireless reporting of internal bodily functions, body position and motion, and/or conditions in the immediate vicinity of a subject, who can be a human or other animal, that consists of

a compact, light-weight, unobtrusive and very low power-consuming instrument apparatus that contains sensors and wireless communication circuitry, attaches to clothing and requires no direct contact with the body;

Firmware and/or software to facilitate intermittent or real time communication and analysis of the data from said instrument apparatus.

6. A system that permits the continuous or intermittent non-invasive measurement and wireless reporting of internal bodily functions, body position and motion, and/or conditions in the immediate vicinity of a subject, who can be a human or other animal, that consists of

a compact, light-weight, unobtrusive and very low power-consuming instrument apparatus that contains sensors, including multiple sensors for similar functions, and wireless communication circuitry, attaches to clothing and requires no direct contact with the body;

Firmware and/or software to facilitate intermittent or real time communication and analysis of the data from said instrument apparatus.

7. A system that permits the continuous or intermittent non-invasive measurement and wireless reporting of respiration rate and/or heart rate of a subject, who can be a human or other animal, that consists of

a compact, light-weight, unobtrusive and very low power-consuming instrument apparatus that contains sensors and wireless communication circuitry, attaches to clothing and requires no direct contact with the body

Firmware and/or software to facilitate intermittent or real time communication and analysis of the data from said instrument apparatus.

* * * * *

专利名称(译)	婴儿和其他无助个体的身体机能的非接触式测量，监测和通信		
公开(公告)号	US20170258339A1	公开(公告)日	2017-09-14
申请号	US15/453911	申请日	2017-03-09
[标]申请(专利权)人(译)	SARHAN萨迈赫		
申请(专利权)人(译)	SARHAN，萨迈赫		
[标]发明人	SARHAN SAMEH		
发明人	SARHAN, SAMEH		
IPC分类号	A61B5/0205 A61B5/00 H04W4/00		
CPC分类号	A61B5/02055 H04W4/005 A61B5/0002 A61B2503/04 A61B5/02438 A61B5/0823 A61B5/14532 A61B5/0816 A61B5/11 A61B5/4806 A61B2560/0242 A61B5/0402 A61B5/6804 H04W4/70		
优先权	62/306463 2016-03-10 US		
其他公开文献	US10470669		
外部链接	Espacenet USPTO		

摘要(译)

一种用于非接触式检测和测量婴儿或其他无助个体存在和存在的各种身体功能和环境条件的方法和系统，以及用于将测量数据传送给远程用户和/或记录和/或解释装置的方法和系统。 一种装置，包括安装在小的，有吸引力的，本质安全的外壳内的所述检测，测量和通信装置，该外壳连接到个人的衣服上。