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(54) Title: RADIATION METER AND METHOD

Fig. 1

(57) Abstract: The present invention relates to a method and radiation monitoring device (10) comprising at least one radiation detector (11), a memory (12) and a controller (12), wherein said radiation detector is arranged to detect at least one type of radiation dose. The memory (12) comprises a number of memory positions configured to store data resulting from said detector (11) detection. The positions are configured to store accumulated measured dose values corresponding to consecutive real time intervals. The controller is configured to continuously compute mean radiation dose values for measured and stored radiation doses during the predetermined time period and for each computation, a resulting mean value is compared with a corresponding predetermined reference value and generate a signal corresponding to result of said comparison.
RADIATION METER AND METHOD

TECHNICAL FIELD

The present invention relates to monitors for radiation, and in particular to radiation dose meters.

BACKGROUND

Human tissue is sensitive for different types of radiation. The radiation which may consist of energy bins may affect cell structures when it hits the human body. Ionizing radiation, for example, can change the structure of the cells, sometimes creating potentially harmful effects that are more likely to cause changes in tissue. These changes can interfere with cellular processes so cells might not be able to divide or they might divide too much, resulting in cancer.

Radiation dose meters are common for use in industries, hospitals, dentist sites, etc. in which the presence of and exposure to low levels of radiation is a hazard and must be monitored. In a hospital or at dentist, for example, patients, physicians and nurses may also encounter situations in which they may risk exposure to radiation and require a means of monitoring such exposure.

The radiation dose meters of today normally provide a direct value in a predetermined unit. However, to present measured values in this way normally is not easy to be understood by none-expert users and to be interpret to a relevant radiation dose situation and consequently unclear for the user how to avoid unnecessary exposure to radiation, which may increase health hazard.

Authorities have specified some radiation dose limits, which should not be exceeded for individuals/groups of people, to reasonably limit humans' health risks for radiation.

US 4,642,463 relates to a radiation monitor, which includes a radiation detector, a digital processor and a display. The digital processor is responsive to externally input information
corresponding to alarm radiation rate, alarm radiation dose and alarm time-to-go. The
digital processor integrates the perceived real time radiation rate to produce total dose
information. The processor can then compare total dose information to alarm dose,
compare sensed radiation rates to alarm rate and compute time-to-go, by dividing the
difference between alarm dose and total dose by the present radiation rate, and finally
comparing computed time-to-go to alarm time to go. The processor initiates an alarm
condition for altering the user of sensed radiation rate exceeds alarm radiation rate, if total
dose information exceeds alarm dose information or if time-to-go, as computed, is less
than alarm time-to-go information. Additional functions performed include determination of
expected dose, first opportunity computations and decay time-to-go computations. In all
these computations the processor is capable of extrapolating predicted radiation rates.
Thus, this document describes a technique using accumulated dose while the present
invention uses continues running mean value and radiation intensity. There is also a
difference in when and how a warning is provided. While the present invention provides a
warning for whether the radiation at the current time is safe or not, this document provides
information on how long it is left before the radiation is unsafe.

US 7,592,603 relates to a radiation detector performing both rate and dose
measurements for personal safety and also to provide measurements that are sufficiently
sensitive for security applications. In one embodiment, a radiation detector has a first
measurement channel and a second measurement channel, where the second
measurement channel can measure radiation at levels that would saturate the first
measurement channel.

SUMMARY OF THE INVENTION

One of the objects of the present invention is to provide an arrangement for measuring
and providing measurement value, which is easy to be apprehended and indicates that
the current radiation dose over a predetermined time interval should be avoided under a
longer time interval to avoid health risks.

For this reason the present invention relates to a radiation monitoring device comprising
at least one radiation detector, a memory and a controller, wherein the radiation detector
is arranged to detect at least one type of radiation dose. The memory comprises a
number of memory positions configured to store data resulting from the detector
detection. The positions are configured to store accumulated measured dose values
corresponding to consecutive real time intervals. The controller is configured to
continuously compute mean radiation dose values for measured and stored radiation
doses during the predetermined time period and for each computation, a resulting mean
value is compared with a corresponding predetermined reference value and generate a
signal corresponding to the comparison. The device may further comprise a display unit.
Depending on one or several current mean values exceeding or being below a
corresponding reference value for a chosen time interval, the controller is configured to
generate a control signal for displaying a specific symbol on the display. The time interval
is one or several of second, minute, hours, day, week, month or year. The memory unit
comprises a number of memory cells, each cell for storing a radiation dose data within a
predetermined time interval, wherein cell
n
is configured to store a radiation dose under a
time interval
n
and cell
n+1
stores radiation dose in a subsequent real time interval. A total
number of cells correspond to a relevant larger time interval than a largest chosen
measuring time interval
n.
The device may be configured to control one or several
indicators to indicate a first symbol apprehended as safe radiation dose exposure and one
or several second symbols apprehended as unsafe radiation dose exposure. The
radiation dose is a functional of dose intensity as a function of a time period, a to t:

\[ \text{Radiation dose} = \int_a^t \text{dose intensity} \, dt \]

The device may be intended for monitoring different type of radiations comprising ionized
radiation, being one or several of alpha particles, beta particles, gamma rays, X-ray
radiation, and neutrons, and non-ionized radiations, being one of several of radio waves,
light (UV and IR) or a combination of radiations. The device may comprise means for
detecting the position on which the device is installed.

The invention also relates to a method of monitoring radiation by means of a radiation
monitoring device comprising at least one radiation detector, a memory and a controller.
The radiation detector is arranged to detect at least one type of radiation dose. The
memory comprises a number of memory positions configured to store data resulting from
the detector detection. The method comprising: storing in the positions accumulated
measured dose values corresponding to consecutive real time intervals, continuously
computing mean radiation dose values for measured and stored radiation doses during
the predetermined time period and for each computation, and comparing a resulting mean
value with a corresponding predetermined reference value and generate a signal
corresponding to the comparison.
BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention is described with references to exemplary embodiments illustrated in the attached drawings, in which:

Fig. 1 is a schematic block diagram of a radiation dose measuring device according to the present invention,
Fig. 2 is an exemplary graph illustrating the relationship between dose intensity and time period for reference dose values and
Fig. 3 illustrates exemplary method steps of the invention.

DETAILED DESCRIPTION

Fig. 1 is a schematic block diagram of a radiation dose measuring device 10 according to the present invention. The device comprises a measuring part 11, a controller 12, and a display unit 13. Power source and other units not relevant for the invention are not illustrated.

The measuring part 11 comprises a detector 111 and a memory unit 112. The measuring part 11 may also comprise (in addition to or instead of detector 111) an input 113 for receiving measured dose. One or several types of detectors may be incorporated.

The memory unit 112 may comprise a number of memory cells, each cell for storing a radiation dose data within a predetermined time interval. The time interval may be a time unit, such as second, minute, hour, day, week, etc. The memory cell structure is configured such that cell_n stores the radiation dose under time interval n and cell_{n+1} stores radiation dose in the subsequent real time interval, and so on. Preferably, the total number of cells should correspond to a relevant much larger time interval than the largest chosen measuring time interval n, e.g. months or years.

The memory unit 112 may be part of the main memory of the device.
The controller is configured to execute instructions (e.g. stored in a memory not shown). The instructions may comprise instruction set for controlling the measuring unit 11, the display unit 13 and other internal functionalities. The instructions also comprise a number of computational instructions which continuously compute (current) mean values for the radiation dose during the predetermined time period (e.g. second, minute, hour, day, week, etc.). For each new computation, the resulting mean value is compared with predetermined reference values. If one or several current mean values exceed corresponding reference value for chosen time interval, a control signal is generated to the display unit 13.

The reference values and time periods may be pre-programmed for specific applications or changed for different applications.

Fig. 2 is an exemplary graph illustrating the relationship between reference doses and time period.

According to graph of Fig. 2 following relations may be valid:
Radiation dose A < Radiation dose B < Radiation dose C
|a| < |b| < |c|

Wherein:
Radiation dose A = \[ \int_{-a}^{\text{now}} \text{dose intensity} \, dt \]
Radiation dose B = \[ \int_{-b}^{\text{now}} \text{dose intensity} \, dt \]
Radiation dose C = \[ \int_{-c}^{\text{now}} \text{dose intensity} \, dt \]

For example, radiation dose A may be 100 \( \mu \text{B} \), radiation dose B may be 200 \( \mu \text{B} \) and radiation dose C may be 300 \( \mu \text{B} \).

When computing, the controller compares radiation dose A with the real radiation dose for the time interval a. If the radiation dose > radiation dose A (reference value according to Fig. 2) a signal is transmitted to the display unit. Same computation and comparisons are made to for the time intervals b and c to radiation doses B and C, respectively.
The display unit 13 comprises, for example a Liquid Crystal Display (LCD) portion 131 (or any other suitable display technique), which may be controlled by the controller 12 or a display driver (not shown), well known for a skilled person. The display portion may be colour display or "black and white". The display unit may also be provided with an identification field 132, identifying the user, i.e. a person or a subject carrying the radiation dose monitoring device 10.

The display unit 13 is configured to provide information to a user in a simple but accurate manner. For this reason the display portion 131 may display a number of symbols reproducing the detected radiation dose. For example, a first symbol 133 may only indicate that the radiation dose is within an acceptable limit by only displaying "OK". One or several symbols 134 may be used to provide information for a time interval during which current radiation dose is compared to respective reference radiation dose. The display portion may also provide information 135 about the position on the user the radiation dose monitoring device is carried.

The position in which the device is carried, is important because the amount of radiation varies depending on, e.g. if the user carries additional protection, field of use etc., and thus the reference values depend on the position.

During the monitoring operation, if none of the current mean values of the measured radiation doses exceed respective reference value, the acceptable limit symbol ("OK") is displayed. If the current radiation dose A exceeds reference radiation dose A, a corresponding symbol (134) may be displayed. This symbol may for example be "Warning", red coloured symbol (or any other warning symbol) or combinations thereof. This symbol may be displayed until measured radiation dose mean value during the latest measuring interval "a" is below the reference radiation dose A. The acceptable limit symbol is off while the warning symbol is displayed. Thus, there is no need for displaying dose level values which are not understood by non-experts.

If several current radiation doses (A, B, C) exceed the respective reference dose (A, B, C), a corresponding symbol may be displayed.

In one embodiment, if the user obtains indication (134) corresponding to a warning, the radiation dose intensity as function of time may be analyzed in more detail. Data in the
memory unit 112 can be transferred to a database using wired or wireless communication, for further analyses.

In yet another embodiment, the device doesn't have a display and continuously communicate with other information displaying units or a central computer at a monitoring site.

The device of the invention may be used for monitoring any type of radiations, e.g. ionized radiation such as alpha particles, beta particles, gamma rays, X-ray radiation, and neutrons, and non-ionized radiations, such as radio waves, light (UV and IR) or a combination of radiations.

In yet another embodiment, the device may be configured to detect the position it is carried on, e.g. by detecting altitude, ambient material, etc.

It should be noted that the word "comprising" does not exclude the presence of other elements or steps than those listed and the words "a" or "an" preceding an element do not exclude the presence of a plurality of such elements. It should further be noted that any reference signs do not limit the scope of the claims, that the invention may be implemented at least in part by means of both hardware and software, and that several "means", "units" or "devices" may be represented by the same item of hardware.

The various embodiments of the present invention described herein is described in the general context of method steps or processes, which may be implemented in one embodiment by a computer program product, embodied in a computer-readable medium, including computer-executable instructions, such as program code, executed by computers in networked environments. A computer-readable medium may include removable and non-removable storage devices including, but not limited to, Read Only Memory (ROM), Random Access Memory (RAM), compact discs (CDs), digital versatile discs (DVD), etc. Generally, program modules may include routines, programs, objects, components, data structures, etc. that perform particular tasks or implement particular abstract data types. Computer-executable instructions, associated data structures, and program modules represent examples of program code for executing steps of the methods disclosed herein. The particular sequence of such executable instructions or
associated data structures represents examples of corresponding acts for implementing
the functions described in such steps or processes.

Software and web implementations of various embodiments of the present invention can
be accomplished with standard programming techniques with rule-based logic and other
logic to accomplish various database searching steps or processes, correlation steps or
processes, comparison steps or processes and decision steps or processes. It should be
noted that the words "component" and "module," as used herein and in the following
claims, is intended to encompass implementations using one or more lines of software
code, and/or hardware implementations, and/or equipment for receiving manual inputs.

The foregoing description of embodiments of the present invention, have been presented
for purposes of illustration and description. The foregoing description is not intended to be
exhaustive or to limit embodiments of the present invention to the precise form disclosed,
and modifications and variations are possible in light of the above teachings or may be
acquired from practice of various embodiments of the present invention. The
embodiments discussed herein were chosen and described in order to explain the
principles and the nature of various embodiments of the present invention and its practical
application to enable one skilled in the art to utilize the present invention in various
embodiments and with various modifications as are suited to the particular use
contemplated. The features of the embodiments described herein may be combined in all
possible combinations of methods, apparatus, modules, systems, and computer program
products.
CLAIMS

1. A radiation monitoring device (10) comprising at least one radiation detector (111), a memory (112) and a controller (12), wherein said radiation detector is arranged to detect at least one type of radiation dose, characterised in that said memory (112) comprises a number of memory positions configured to store data resulting from said detector (111) detection, said positions being configured to store accumulated measured dose values corresponding to consecutive real time intervals, and that said controller is configured to continuously compute mean radiation dose values for measured and stored radiation doses during a predetermined time period and for each computation, compare a resulting mean value is with a corresponding predetermined reference value and generate a signal corresponding to result of said comparison.

2. The device of claim 1, further comprising a display unit (13).

3. The device of claim 2, wherein depending on one or several current mean values exceeding or being below a corresponding reference value for a chosen time interval, the controller is configured to generate a control signal for displaying an specific symbol on said display.

4. The device according to any of preceding claims, wherein said time interval is one or several of second, minute, hour, day, week, month or year.

5. The device according to any of preceding claims, wherein said memory unit (112) comprises a number of memory cells, each cell for storing a radiation dose data within a predetermined time interval, wherein cell_{n} is configured to store a radiation dose under a time interval {n} and cell_{n+1} stores radiation dose in a subsequent real time interval.

6. The device of claim 5, wherein a total number of cells corresponds to a relevant larger time interval than a largest chosen measuring time interval {n}.

7. The device of claim 2, being configured to control one or several indicators to indicate a first symbol apprehended as safe radiation dose exposure and one or several second symbols apprehended as unsafe radiation dose exposure.
8. The device according to any of preceding claims, wherein said radiation dose is a functional of dose intensity as a function of a time period - a to t:

\[
\text{Radiation dose} = \int_a^t \text{dose intensity } dt
\]

9. The device according to any of preceding claims, for monitoring different type of radiations comprising ionized radiation, being one or several of alpha particles, beta particles, gamma rays, X-ray radiation, and neutrons, and non-ionized radiations, being one of several of radio waves, light (UV and IR) or a combination of radiations.

10. The device according to any of preceding claims, comprising means for detecting the position on which the device is installed.

11. A method of monitoring radiation by means of a radiation monitoring device (10) comprising at least one radiation detector (111), a memory (112) and a controller (12), wherein said radiation detector is arranged to detect at least one type of radiation dose, said memory (112) comprising a number of memory positions configured to store data resulting from said detector (111) detection, the method comprising:

- storing in said positions accumulated measured dose values corresponding to consecutive real time intervals,
- continuously computing mean radiation dose values for measured and stored radiation doses during the predetermined time period and for each computation, and
- comparing a resulting mean value with a corresponding predetermined reference value and generate a signal corresponding to result of said comparison.

12. The method of claim 11, wherein based on result of said comparison:

- presenting a first symbol comprehended as a safe radiation dose level, or
- presenting a second symbol comprehended as an unsafe radiation dose level.
A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: G01T

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC, XPSPRING

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>US 4642463 A1 (THOMS WILLIAM H), 10 February 1987 (1987-02-10); abstract; column 3, line 10 - line 36; column 3, line 62 - line 67; column 5, line 1 - line 2; column 10, line 67 - column 11, line 3; column 17, line 48 - line 64</td>
<td>1, 2, 4-6, 8-11</td>
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International Patent Classification (IPC)

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