ACTIVITY MONITORING APPARATUS WITH CONFIGURABLE FILTERS

BACKGROUND OF THE INVENTION

The subject invention relates to apparatus and methods for monitoring activity of the human body. More particularly, the invention relates to apparatus, systems and methods by which the occurrence and length of certain types of body movements which form activity phenomenon can be selectively observed and accurately quantified.

A human subject engages in a wide range of body movements. Such movements can range from the voluntary and visually perceptible—such as the movement of legs, arms and head, to the involuntary and visually imperceptible, such as the slight changes in elevation of skin caused by the rhythmic pulsations of blood and breathing.

The observation of body movement can provide much information useful to physicians and researchers. For example, by observing a subject's movements, the occurrence and length of natural phenomenon, such as wakefulness, rest and sleep can be determined. By observing the nature of a subject's movement, the occurrence and severity of disorders and the effects of drugs or other therapy can be assessed. In many cases quantification of the subject's movement is preferred so that the movement pattern of one subject can be compared with the movement pattern of others.

Direct visual observations of body movement are labor intensive, time consuming and tedious. Moreover, direct visual observations provide only a limited range of qualitative information, such as subjective descriptions of a subject's visually perceptible movements. Little, if any, quantification in readily comparable values, such as degree, strength, and/or violence of a subject's activity, and no information, either qualitative or quantitative, of a subject's visually imperceptible movements is obtained. Furthermore, the value of qualitative information obtained by directly observing a subject is subject to question as such observations themselves may cause the subject to become conscious of and thereby alter his or her movements.

Activity monitors have been developed for observing and quantifying certain aspects of movement without the involvement of an observer. However, such monitors had disadvantages which limited their usefulness. For example, such prior monitors were typically of a size which interfered with free movement of the subject, and typically had either little or no internal memory and/or little or no data processing capabilities. In order that data produced by many of these activity monitors could be stored and/or processed it was necessary to connect the monitors through cables to external data storage and processing devices. Tethering the monitor in this way to an external device also tethered the subject to the device, thereby restricting the subject's movement and biasing the results.

In those prior activity monitors which had internal memory, saturation of the memory occurred when the subject engaged in activity which produced a volume of data that, for the period of time over which the subject was being monitored, exceeded the capacity of the memory.

This problem was aggravated because prior activity monitors were not selectively configurable to collect data only for a particular activity, so that unusable or irrelevant data was often allowed to occupy memory space along with usable data. Prior monitors did not have the capability to be reconfigured according to preset instructions and/or in response to the data collected by the monitor.

Prior monitors typically utilized sensors to detect body movement which, because of the need to suppress harmonics and other artifacts from the limited memory, lacked the sensitivity to detect small scale, visually imperceptible movements such as those caused by breathing, the beat of the heart, and the flow of blood.

A demand therefore exists for an activity monitor and method by which the activity of a subject, even that activity which includes movements that are not necessarily visually perceptible, can be selectively observed and accurately quantified. The present invention satisfies this demand.

Accordingly, it is a general object of the present invention to provide an improved apparatus, system and methods for selectively observing and accurately quantifying certain aspects of the motion of a subject.

An object of the present invention is to provide an activity monitor having a size and construction such that the monitor may be conveniently worn on the subject.

Another object of the present invention is to provide an activity monitor which can collect data regarding a subject's activity automatically and according to instructions initialized in the monitor.

Another object of the present invention is to provide an activity monitor having a memory in which operating instructions and collected data are stored.

Another object of the present invention is to provide an activity monitor with which data regarding a subject's movement can be processed automatically and according to instructions initialized in the monitor.

Another object of the present invention is to provide an activity monitor wherein the type of data collected and the processing of the data by the monitor can be automatically changed.

SUMMARY OF THE INVENTION

The present invention is directed to an activity monitor and methods by which both visually perceptible and visually imperceptible movement can be selectively observed and accurately quantified.

The apparatus includes an activity monitor, or actigraph, having a size, shape and construction that allows the monitor to be worn on the surface of the skin of a subject and which functions reliably and without restriction of the subject's movement. One preferred embodiment of the monitor of the present invention is configured for wearing on a subject's non-dominant wrist. The monitor may be configured to be worn on other parts of a subject's body as well.

In particular, the activity monitor of the present invention includes a movement sensor by which the full range of a subject's movement, even that which is visually imperceptible, can be detected. A preferred sensor is a cantilever piezoelectric bimorph beam. The use of a bimorph beam as a sensor is advantageous in that it provides high sensitivity and operates without requiring any operating power, such as from a battery, thereby conserving this generally limited resource. Furthermore, such a sensor operates in the absence of a gravitational field thereby expanding the applications in which the monitor can be utilized.