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**PRODUCT INTEGRITY SYSTEMS AND
ASSOCIATED METHODS**

RELATED APPLICATIONS

This application is a continuation of commonly-owned and copending application Ser. No. 10/297,270 filed Dec. 4, 2002, which claims priority to PCT Application No. PCT/US01/51620, filed Dec. 17, 2001 and to the following six U.S. provisional applications: U.S. Provisional Application No. 60/256,069, filed Dec. 15, 2000; U.S. Provisional Application No. 60/257,386, filed Dec. 22, 2000; U.S. Provisional Application No. 60/259,271, filed Dec. 29, 2000; U.S. Provisional Application No. 60/261,359, filed Jan. 13, 2001; U.S. Provisional Application No. 60/285,032, filed April 19, 2001; and U.S. Application No. 60/323,601, filed Sep. 20, 2001. The foregoing applications are expressly incorporated herein by reference.

FIELD OF THE INVENTION

The invention relates to sensing systems monitoring applications shipping and industrial production.

BACKGROUND

The movement of objects and persons occurs continuously but is hardly quantified. Rather, typically only the result of the movement is known (i.e., object X moved from point A to point B; or, person Y ran to the store). Advances in technology have provided some quantification of movement. For example, GPS products now assist in determining the location of golf carts, vehicles and persons.

However, the detail of movement, minute to minute, second to second, is still not generally determinable in the prior art. For example, the movement of tangible objects typically involves (a) the shipment or carrying of goods and (b) electromechanical or motorized apparatus (e.g., planes, trains, automobiles, robots). The exact movements of such objects, and the conditions that they are subjected to, from point to point, are only qualitatively known. By way of example, a package is moved from location to location through delivery services like FEDERAL EXPRESS or UPS; however what occurred during transportation, and what transpired to the package, is anyone's guess. Occasionally, an object within the package is broken, indicating that the package experienced excessive abuse; but whose fault it is, or how or when it happened, are not known. What environments the package experienced is also not readily known.

The movement of persons, on the other hand, typically involves human-powered transportation, e.g., facilitated by biking, a wheelchair, or a motorized vehicle, e.g., a car. Body movement involved in transportation is subjected to many forces, some of which are dangerous. But the prior art does not provide for this knowledge; there is no effective way, currently, to efficiently quantify human movement. In sports, physical fitness, and training, precise information about movement would assist in many ways. By way of example, how effective a hand strike is in karate or boxing is, today, only qualitatively known. Quantitative feedback would be beneficial.

It is, accordingly, one feature of the invention to provide systems and methods addressing the afore-mentioned difficulties. A further feature of the invention is to provide methods and devices to quantify movement in a number of applications. Another feature of the invention is to monitor

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and report meaningful environment information such as temperature and humidity. These and other features will be apparent in the description that follows.

SUMMARY OF THE INVENTION

Movement Monitoring Devices

In one aspect, the invention provides a movement monitor device ("MMD") including an adhesive strip, a processor, a detector, and a communications port. In another aspect, two or more of the processor, port and detector are combined in a single application specific integrated circuit ("ASIC"). In one aspect the detector is an accelerometer, and preferably an accelerometer embedded into silicon within the ASIC. In other aspects, the detector is one of a strain gauge, force-sensing resistor, and piezoelectric strip. In still another aspect, the MMD includes a battery. In the preferred aspect of the invention, the MMD and battery are packaged in a protective wrapper. Preferably, the battery is packaged with the MMD in such a way that it does not "power" the MMD until the wrapper is removed. Preferably, the MMD includes a real time clock so that the MMD tags "events" (as hereinafter defined) with time and/or date information.

In yet another aspect, the MMD with adhesive strip collectively take a form similar to an adhesive bandage. More particularly, the adhesive strip of the invention is preferably like or similar to the adhesive of the adhesive bandage; and the processor (or protective wrapper) is embedded with the strip much the way the cotton is with the adhesive bandage. Preferably, a soft material (e.g., cotton or cloth) is included to surround the processor so as to (a) soften contact of rigid MMD components with a person and/or (b) protect the processor (and/or other components of the MMD). In still another aspect, the battery is also coupled with the soft material. In still another aspect, the processor and other elements of the MMD are combined into a single system-on-chip integrated circuit. A protective cover may surround the chip to protect the MMD from breakage.

In one aspect, one MMD of the invention takes a form similar to a smart label, with an adhesive substantially disposed with the label, e.g., on one side of the label. The adhesive strip of this MMD includes all or part of the back of the label with adhesive or glue permitting attachment of the label to other objects (or to a person).

In still another aspect, the MMD of the invention takes the form of a rigid monolithic that attaches to objects through one of known techniques. In this aspect, the device has a processor, communications port, and detector. A battery is typically included with the MMD. The MMD is attached to objects or persons by one of several techniques, including by glue or mechanical attachment (e.g., a pin or clip). An MMD of this aspect can for example exist in the form of a credit card, wherein the communications port is either a contact transponder or a contactless transponder. The MMD of one aspect includes a magnetic element that facilitates easily attaching the MMD to metal objects.

In operation, the MMD of the invention is typically interrogated by an interrogation device ("ID"). The MMD is responsive to the ID to communicate information within the MMD and, preferably, over secure communications protocols. By way of example, one MMD of the invention releases internal data only to an ID with the correct passwords and/or data protocols. The ID can take many forms, including a cell phone or other electronic device (e.g., a MP3 player, pager, watch, or PDA) providing communications with the MMD transmitter