EUROPEAN PATENT SPECIFICATION

SYSTEM FOR DETECTING AND QUANTIFYING ACTIVITIES PERFORMED IN WORKING AND MANUFACTURING PROCESSES

SYSTEM ZUM DETEKTIEREN UND QUANTIFIZIEREN VON IN EINEM ARBEITS- UND HERSTELLUNGSPROZESS AUSGEFÜHRTEN AKTIVITÄTEN

SYSTÈME POUR DÉTECTOR ET QUANTIFIER LES ACTIVITÉS EXÉCUTÉES LORS DE PROCÉDÉS DE TRAVAIL ET DE FABRICATION

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).
The present invention refers to a system for detecting/quantifying activities performed in working and manufacturing processes.

As known, any complex working/manufacturing process is often composed of various steps, to which the following times correspond: actual manual and/or mechanical working times, logistic handling times, various types of idle times, etc.

While some times (such as, for example, machine working times) can be easily measured, the times referred to actual human activities cannot, for can be measured with a high waste of resources. In fact, it is a problem to analyse the manual working phase in detail, to obtain, for example, an evaluation of idle times. A real evaluation could be made through the direct observation by a process responsible, but with obvious high consumption of energies and costs.

Usually such times are then evaluated approximately, through a stamping (with cards, badges, etc.) of start-end of works, that obviously is not able to provide accurate indications about what occurs within such time window.

From what is stated above, it follows that it is difficult to identify the phase of actual operator’s activities, cleaned from idle times; moreover, a series of important disadvantages are created, with problems for efficiency and final incomes, such as:

- difficulty in quantifying the exact cost of the manual operation;
- difficulty in evaluating operator’s performances;
- difficulty in optimising the working process.

For example, in the automotive field, think about the activities performed in a repair workshop; by measuring them through stamping the start and end of works, a total time is simply detected which includes all idle times of the mechanical operator (for example, times for recovering spare parts, logistic transport times for external working, pauses, etc.).

The workshop responsible, not being able to constantly monitor a single repair activity, in order to quantify the intervention labour time, uses theoretical reference time lists or start and end of works stamping time lists; however, in no ways it is thereby possible to obtain the actual worked time (stamping for example does not detect idle times and time lists do not provide for possible working variations).

It results an incorrect labour cost of the operation, a difficult evaluation of mechanics operator performance, and possible idle or dead times remain not able to be evaluated, making it very difficult to optimise the process.

Systems comprising accelerometers are known in the art, and are adapted to verify the movement of an athlete to substantially calibrate his training loads, such as those described for example in prior patents n. GB-A-2234070, US-A-7373820, US-A-2007208530 and WO-A-2005013101, that cannot clearly be used for detecting and measuring human and/or mechanical activities performed on an object in industrial working and manufacturing processes. EP-A-1 246 136 and DE-A-10345883 disclose methods and systems applied onto human workers or not usable for detecting human activities on objects.

Therefore, object of the present invention is solving the above prior art problems, by providing a system for detecting/quantifying activities, both human and/or animal and/or mechanical activities, performed in working and manufacturing processes that automatically allows measuring, in a sure and accurate way, the actual activities performed in time by an operator by reading accelerations, microaccelerations and vibrations that he produces during his action on the object being worked.

Another object of the present invention is providing a system for detecting/quantifying activities, both human and/or animal and/or mechanical activities, performed in working and manufacturing processes that allows providing pieces of information about actually performed activities, therefore cleaned from possible interferences, and automatically detecting and classifying idle times.

The above and other objects and advantages of the invention, as will appear from the following description, are obtained by a system for detecting/quantifying activities performed in working and manufacturing processes as claimed in claim 1. Preferred embodiments and non-trivial variations of the present invention are the subject matter of the dependent claims.

It will be immediately obvious that numerous variations and modifications (for example related to shape, sizes, arrangements and parts with equivalent functionality) can be made to what is described, without departing from the scope of the invention, as appears from the enclosed claims.

The present invention will be better described by some preferred embodiments thereof, provided as a non-limiting example, with reference to the enclosed drawings, in which:

- FIG. 1 shows a block diagram of a preferred embodiment of the system for detecting/quantifying activities performed in working and manufacturing processes according to the present invention;
- FIG. 2 shows a block diagram of another preferred embodiment of the system for detecting/quantifying activities performed in working and manufacturing processes.
With reference to FIG. 1, it is possible to note that the system 1 for detecting/quantifying human and/or animal and/or mechanical activities performed on at least one object 4 in working and manufacturing processes according to the present invention comprises:

- at least one accelerometric sensor 3, arranged integrally on such object 4 subjected to the working and/or manufacturing process, such accelerometric sensor 3 being adapted to measure the physical quantities produced by such mechanical and/or human and/or animal activities, and in particular of accelerations, operating on such object 4, preferably for all axes that the sensor 3 itself is capable of detecting;
- interface and processing means 5 adapted to receive pieces of information 6 related to instantaneous measures of the physical quantities sent by such accelerometric sensor 3, such interface and processing means 5 being adapted, in particular, to make uniform and process such pieces of information 6 of physical quantities measured by the accelerometric sensor 3;
- communication interface means 7 adapted to send to such upper-level hardware and/or software means 9 such pieces of information made uniform and processed 8 produced by the interface and processing means 5.

The system 1 according to the present invention therefore allows detecting very accurately every single action performed by an operator (human, mechanical and/or animal operator) on the object 4 of working, measuring accelerations produced by such activities in the various spatial directions, and then to detect the actual status of operator’s activities in time.

Preferably, the accelerometric sensor 3 can be of the "solid-state" type, but it is wholly clear that any other type of sensors can be used, such as of the mechanical type.

Obviously, the number of accelerometric sensors 3 arranged on the object 4 can be various and depends, for example, on the number and arrangement of axes along which the necessary physical quantities and/or the sizes of the object 4 are measured.

As stated, the accelerometric sensors 3 must be arranged on the object 4 of working in a constrained way; the connection between each sensor 3 and the object 4 can obviously be with a simple abutment or fixed through several methods of mechanical gluing, screw-bolt and/or by possibly interposing elastic elements such as springs, etc.) or magnetic fastening.

The system 1 according to the present invention therefore allows analysing the activities performed on the object 4 and detected by comparison with mapping/patterns of typical sequences of accelerations and the use of artificial intelligence constructs (such as, for example, neural networks, inertial motor, expert systems, etc.), providing truthful indications about the type of produced activities. Very importantly, there is the capability of producing pieces of information 8 with high time definition (by several orders of magnitude higher than the characteristic times of manually produced activities on the object 4), that enables a deep real-time analysis even when performing working.

The system 1 according to the present invention, the physical quantities measured by the accelerometric sensors 3 are afterwards processed and transmitted to the upper-level hardware and/or software means 9 adapted to sample such pieces of information 8, with a time period that can be configured depending on the desired type of use, and to process them in order to perform a logical analysis and a semantic deduction of activities corresponding to the set and/or subsets of such pieces of information 8, for example by locating common pattern to the typical activities which have to be monitored.

Merely as an example, such pieces of information 8 can be classified into two main typologies:

- discrete value of voltage generated by the accelerometric sensor 3 depending on acceleration and direction (according to the type of accelerometric sensor 3 used, with one, two or three axes X, Y, Z), that describes the acceleration value produced;
- time.

The communication interface means 7 can obviously be operatively connected for transmitting the pieces of information 8 with the interface and processing means 5 and the upper-level hardware and/or software means 9 through any communication technology suitable for such purpose, being it wired and/or wireless (for example: RS232, USB, Infrarossi, Bluetooth, WiFi, custom RF comm, etc.).

Preferably, but obviously in a non-limiting way, the upper-level hardware and/or software means 9 are made of at least one personal computer.
The applications of the system 1 according to the present invention are then several and adapted to the most different working and/or manufacturing processes: merely as an example, FIG. 3a, 3b and 3c show the results of using the system 1 according to the present invention for monitoring the mechanical working activities performed in an Automotive workshop; this measure has produced the results included in the graphs of FIG. 3a, 3b and 3c, from which the potentialities of the system 1 are pointed out, together with its capability of detecting phases of activity 31 and phases of lack of activity 33 on a car representing the object 4, depending on accelerations (in the ordinates on the graphs) measured by the accelerometric sensors 3 in general with respect to a triad of Cartesian axes (FIG. 3a), on an elevator bridge (FIG. 3b) and on an engine (FIG. 3c) of the car itself, in addition to distinguishing them on the time axis included in the graphs as abscissas.

In particular, in the specific Automotive sector, the system 1 according to the present invention could operatively cooperate and/or be integrated with at least one substantially known numbering system 12 of the worked and/or processed object 4 (for example, cube for numbering the car being worked). Alternatively or in addition, the system 1 according to the present invention could operatively cooperate and/or be integrated with at least one substantially known system 14 for managing workshop activities/productivity and/or with a labour-allocation system 16.

Claims

1. System (1) applied to an object (4) for detecting/quantifying in time human activities externally and actually performed on the object (4) in working and production processes, comprising:

   - at least one accelerometer (3), placed in a constrained way on said object (4), said accelerometer (3) being adapted to measure in time some physical quantities produced by said human activities externally acting on said object (4);
   - interfacing and processing means (5) adapted to receive data (6) relative to instantaneous detections of said physical quantities sent by said accelerometer (3), said interfacing and processing means (5) being adapted to process said data (6);
   - communication interfacing means (7) adapted to send, to upper-level hardware and/or software means (9), said processed data (8) produced by said interfacing and processing means (5), and wherein said upper-level hardware and/or software means (9) are adapted to sample said processed data (8) and to process said processed data (8) in order to perform a logical analysis and a semantic deduction of said activities corresponding to the set and/or subsets of said processed data (8).

2. System (1) according to claim 1, characterised in that said accelerometer (3) is of the "solid-state" type.

3. System (1) according to claim 1, characterised in that said accelerometer (3) is of the mechanical type.

4. System (1) according to claim 1, characterised in that said constrained link between said accelerometer (3) and said object (4) is a plain support or they are linked mechanically and/or by interposing elastic means or are magnetically fixed.

5. System (1) according to claim 1, characterised in that said communication interfacing means (7) are operatively connected for transmitting said data (8) to said interfacing and processing means (5) and said hardware and/or software upper level means (9) by means of a "wired"-type communication.

6. System (1) according to claim 1, characterised in that said communication interfacing means (7) are operatively connected for transmitting said data (8) to said interfacing and processing means (5) and said upper-level hardware and/or software means (9) by means of a "wireless"-type communication.

7. System (1) according to claim 1, characterised in that said upper-level hardware and/or software means (9) are at least one personal computer.

8. System (1) according to the previous claims, characterised in that at least said accelerometer (3), said interfacing and processing means (5), said communication interfacing means (7) and relative connections adapted to allow a transmission of a flow of said data (6, 8) constitute a sensor (2) of mechanical and/or human and/or animal activities performed on said object (4).

9. System (1) according to claim 8, characterised in that at least one interface (HUB) (10) adapted to transmit said data (8) is interposed between at least
one said sensor of mechanical and/or human and/or animal activity (2) and said hardware and/or software upper level means (9).

10. System (1) according to the previous claims, characterised in that it operatively cooperates and/or is integrated with at least one numeration system (12) of said object (4) and/or at least one workshop activity/productivity managing system (14) and/or one labour hour allocation system (16).

Patentansprüche

1. System (1), das an einem Gegenstand (4) angebracht wird, um im Laufe der Zeit menschliche Aktivitäten zu erfassen/quantifizieren, die extern und intern am Gegenstand (4) in Bearbeitungs- und Herstellungsprozessen ausgeführt werden, mit:

   - mindestens einem Beschleunigungsmesser (3), der fest an den Gegenstand (4) gebunden ist, der genannte Beschleunigungsmesser (3) dient dazu, im Laufe der Zeit die physikalischen Größen zu messen, die durch die genannten menschlichen Aktivitäten erzeugt werden, welche extern auf den genannten Gegenstand (4) einwirken;
   - Schnittstellen- und Bearbeitungsgeräte (5), die dazu dienen, Daten (6) der Momenterfassungen der genannten physikalischen Größen zu empfangen, die vom genannten Beschleunigungsmesser (3) gesendet werden, die genannten Schnittstellen- und Bearbeitungsgeräte (5) dienen dazu, die genannten Daten (6) zu bearbeiten;
   - Schnittstellen-Kommunikationsgeräte (7), die dazu dienen, die genannten bearbeiteten Daten (8) über hochwertige Hardware- und/oder Softwaregeräte (9) zu senden, die die genannten Schnittstellen- und Bearbeitungsgeräte (5) erzeugt wurden; und in denen
die genannten hochwertigen Hardware- und/oder Softwaregeräte (9) dazu dienen, die genannten bearbeiteten Daten (8) zu bemustern und die genannten bearbeiteten Daten (8) zu bearbeiten, um eine logische Analyse und eine semantische Deduktion der genannten Aktivitäten auszuführen, die der Gruppe und/oder Untergruppen der genannten bearbeiteten Daten (8) entsprechen.

2. System (1) gemäß Patentanspruch 1, das dadurch gekennzeichnet ist, dass der Beschleunigungsmesser (3) ein "Solid-State" Typ ist.

3. System (1) gemäß Patentanspruch 1, das dadurch gekennzeichnet ist, dass der Beschleunigungsmesser (3) ein mechanischer Typ ist.

4. System (1) gemäß Patentanspruch 1, das dadurch gekennzeichnet ist, dass die genannte feste Verbindung zwischen dem genannten Beschleunigungsmesser (3) und dem genannten Gegenstand (4) einfach zur Unterstützung dient oder dass diese mechanisch und/oder durch Dazwischenlegen von elastischen Elementen oder magnetisch befestigt sind.

5. System (1) gemäß Patentanspruch 1, das dadurch gekennzeichnet ist, dass die genannten Schnittstellen-Kommunikationsgeräte (7) für den Betrieb verbunden sind, um die genannten Daten (8) mit den genannten Schnittstellen- und Bearbeitungsgeräten (5) und den genannten hochwertigen Hardware- und/oder Softwaregeräten (9) durch eine "wired" Kommunikation zu übertragen.

6. System (1) gemäß Patentanspruch 1, das dadurch gekennzeichnet ist, dass die genannten Schnittstellen-Kommunikationsgeräte (7) für den Betrieb verbunden sind, um die genannten Daten (8) mit den genannten Schnittstellen- und Bearbeitungsgeräten (5) und den genannten hochwertigen Hardware- und/oder Softwaregeräten (9) durch eine "wireless" Kommunikation zu übertragen.

7. System (1) gemäß Patentanspruch 1, das dadurch gekennzeichnet ist, dass die genannten hochwertigen Hardware- und/oder Softwaregeräte (9) mindestens aus einem Personal Computer bestehen.

8. System (1) gemäß den vorhergehenden Patentansprüchen, das dadurch gekennzeichnet ist, dass mindestens der genannte Beschleunigungsmesser (3), die genannten Schnittstellen- und Bearbeitungsgeräte (5), die genannten Schnittstellen-Kommunikationsgeräte (7) und die entsprechenden Verbindungen, die dazu dienen, eine Übertragung eines Flusses der genannten Daten (6, 8) zu ermöglichen, einen Sensor (2) der mechanischen und/oder menschlichen und/oder tierischen Aktivitäten, die an dem genannten Gegenstand (4) ausgeführt werden, darstellen.

9. System (1) gemäß Patentanspruch 8, das dadurch gekennzeichnet ist, dass zwischen mindestens einem genannten Sensor der mechanischen und/oder menschlichen und/oder tierischen Aktivität (2) und den genannten hochwertigen Hardware- und/oder Softwaregeräten (9) mindestens eine Schnittstelle (HUB) (10) liegt, die zur Übertragung der genannten Daten (8) dient.

10. System (1) gemäß den vorhergehenden Patentansprüchen, das dadurch gekennzeichnet ist, dass
es im Betrieb mitarbeitet und/oder mit mindestens einem Nummerierungssystem (12) des genannten Gegenstandes (4) und/oder mindestens einem Verwaltungssystem der Aktivität/Produktivität der Werkstatt (14) und/oder mit einem Zuordnungssystem der Arbeitsstunden (16) integriert ist.

Revendications

1. Système (1) appliqué à un objet (4) pour relever/quantifier au cours du temps des activités humaines exécutées à l’extérieur et à l’intérieur de l’objet (4) dans des processus de travail et de production, comprenant :
- au moins un accéléromètre (3), assujetti à l’objet (4), pouvant mesurer au cours du temps les grandeurs physiques produites par ces activités humaines agissant à l’extérieur de l’objet (4) ;
- moyens d’interface et d’élaboration (5) servant à recevoir les données (6) relatives aux relevés instantanés des grandeurs physiques envoyées par l’accéléromètre (3), ces moyens d’interface et d’élaboration (5) permettent de traiter ces données (6) ;
- moyens d’interface de communication (7) permettant d’envoyer, à des moyens matériels et/ou logiciels de niveau supérieur (9), les données élaborées (8) produites par les moyens d’interface et d’élaboration (5) ; et où les moyens matériels et/ou logiciels de niveau supérieur (9) permettent d’échantillonner les données élaborées (8) et de les traiter pour exécuter une analyse logique et une déduction sémantique des activités correspondant à l’ensemble et/ou aux sous-ensembles des données élaborées (8).

2. Système (1) selon la revendication 1, caractérisé en ce que l’accéléromètre (3) est de type “solid-state”.

3. Système (1) selon la revendication 1, caractérisé en ce que l’accéléromètre (3) est de type mécanique.

4. Système (1) selon la revendication 1, caractérisé en ce que la connexion solidaire entre l’accéléromètre (3) et l’objet (4) est constituée par un simple appui ou bien ceux-ci sont fixés mécaniquement et/ou avec interposition d’éléments élastiques ou sont fixés magnétiquement.

5. Système (1) selon la revendication 1, caractérisé en ce que les moyens d’interface de communication (7) sont reliés opérationnellement pour transmettre les données (8) aux moyens d’interface et d’élaboration (5) et aux moyens matériels et/ou logiciels de niveau supérieur (9) à travers une communication de type “wired”.

6. Système (1) selon la revendication 1, caractérisé en ce que les moyens d’interface de communication (7) sont reliés opérationnellement pour transmettre les données (8) aux moyens d’interface et d’élaboration (5) et aux moyens matériels et/ou logiciels de niveau supérieur (9) à travers une communication de type “wireless”.

7. Système (1) selon la revendication 1, caractérisé en ce que les moyens matériels et/ou logiciels de niveau supérieur (9) sont constitués au moins par un ordinateur.

8. Système (1) selon les revendications précédentes, caractérisé en ce que, au moins, l’accéléromètre (3), les moyens d’interface et d’élaboration (5), les moyens d’interface de communication (7) et les connexions relatives permettant une transmission d’un flux des données (6, 8) constituent un capteur (2) des activités mécaniques et/ou humaines et/ou animales exécutées sur l’objet (4).

9. Système (1) selon la revendication 8, caractérisé en ce que l’entre un capteur d’activité mécanique et/ou humaine et/ou animale (2) au moins et les moyens matériels et/ou logiciels de niveau supérieur (9) est interposée au moins une interface (HUB) (10) permettant la transmission des données (8).

10. Système (1) selon les revendications précédentes, caractérisé par le fait de coopérer opérationnelle et/ou d’être intégré à un système de numérotation (12) de l’objet (4) au moins et/ou un système de gestion de l’activité/productivité d’atelier (14) au moins et/ou un système d’affectation d’heures de main-d’œuvre (16).
General activity on 3 axes

FIG. 3a

Elevator bridge

FIG. 3b
FIG. 3c
REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader’s convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- GB 2234070 A [0009]
- US 7373820 A [0009]
- US 2007208530 A [0009]
- WO 2005013101 A [0009]
- EP 1246136 A [0009]
- DE 10345883 A [0009]