**(54) Title:** SYSTEM FOR DETECTING AND QUANTIFYING ACTIVITIES PERFORMED IN WORKING AND MANUFACTURING PROCESSES

![FIG. 1](image)

**(57) Abstract:** A system (1) is described for detecting/quantifying human and/or animal and/or mechanical activities performed on at least one object (4) in working and manufacturing processes, comprising at least one accelerometric sensor (3), integrally arranged on such object (4), such accelerometric sensor (3) being adapted to measure the physical quantities produced by such human and/or mechanical and/or animal activities performed on such object (4), interface and processing means (5) adapted to receive pieces of information (6) related to instantaneous measures of such physical quantities sent by such accelerometric sensor (3), such interface and processing means (5) being adapted to make uniform and process the pieces of information (6), and communication interface means (7) adapted to send to upper-level hardware and/or software means (9) the pieces of information made uniform and processed (8) produced by the interface and processing means (5).
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, or 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.

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 is able to operate perfectly automatically and independently, allowing to reduce the observation and monitoring time by responsible people for the processes themselves.

Moreover, an 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 according to
  the present invention;
FIG. 3a, 3b and 3c show example graphs produced by the system according to the present invention when detecting/quantifying mechanical working activities in the automotive sector.

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 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.

Through 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 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, inferential 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.

Through the system 1 according to the present invention, it is obviously also possible to transfer the pieces of information 6 and/or 8 remotely, through wired or wireless network connections. In particular, it can be noted that, from a functional point of view, the accelerometric sensor 3, the interface and processing means 5, the communication interface means 7 and the related connections adapted to allow transmitting the flow of pieces of information 6, 8 can virtually compose a single sensor 2 of mechanical and/or human and/or animal activities performed on the object 4. With reference to FIG. 2, it is then possible to make networks comprising one or more sensors 2 of mechanical and/or human and/or animal activities operating also simultaneously: in this case, the sensors 2 of mechanical and/or human and/or animal activities communicate with the upper-level
hardware and/or software means 9, preferably by interposing at least one wired or wireless interface (HUB) 10 capable of distinctly collecting all made-uniform and processed pieces of information 8 sent by the single sensors 2 of mechanical and/or human and/or animal activities, and to send them serially towards the upper-level hardware and/or software means 9.

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-allocating system 16.
CLAIMS

1. System (1) for detecting/quantifying human and/or animal and/or mechanical activities performed on at least an object (4) in working and production processes, characterised in that it comprises:

- at least one accelerometer (3), placed in a constrained way on said object (4), said accelerometer (3) being adapted to measure some physical quantities produced by said human and/or animal and/or mechanical activities 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 make said data (6) uniform and process said data (6);

- communication interfacing means (7) adapted to send, to upper-level hardware and/or software means (9), said uniformed and processed data (8) produced by said interfacing and processing means (5).

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).
General activity on 3 axes

FIG. 3a

Elevator bridge

FIG. 3b
### A. CLASSIFICATION OF SUBJECT MATTER

INV. G07C1/10  G07C3/00  G07C3/08

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)

G07C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate of the relevant passages</th>
<th>Relevant to claim</th>
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Further documents are listed in the continuation of Box C.

Date of the actual completion of the international search: 1 December 2009

Date of mailing of the international search report: 08/12/2009

Name and mailing address of the ISA:

European Patent Office, P B 5818 Patentlaan 2 NL - 2280 HV RUSWIJK Tel (+31-70) 340-2040 Fax (+31-70) 340-3016

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