

# ORIGINAL

## ABSTRACT

### METHOD FOR PROCESSING INFORMATION AND ACTIVITIES IN A TECHNICAL CONTROL AND/OR REGULATING SYSTEM USING A MULTICORE PROCESSOR

A method for processing information and activities in a technical control and/or regulating system, wherein technical control and/or regulating tasks are performed by a microcontroller (5), wherein the technical control and/or regulating system includes various components (1, 3), and the microcontroller (5) includes information that is evaluated and processed by the same, and outputs at least one output signal as a result of technical control and regulating calculations. In one embodiment, the method includes dividing the technical control and regulating tasks of the system into component-specific task complexes, where a first component-specific task complex is processed by a first computer core (6) of the microcontroller (5) and a second component-specific task complex is processed by a second computer core (7) of the microcontroller (5). The first component-specific task complex includes reading and/or processing of information of a sensor (1) by the first computer core (6) and the second component-specific task complex includes controlling and/or regulating an actuator (3) by the second computer core (7).

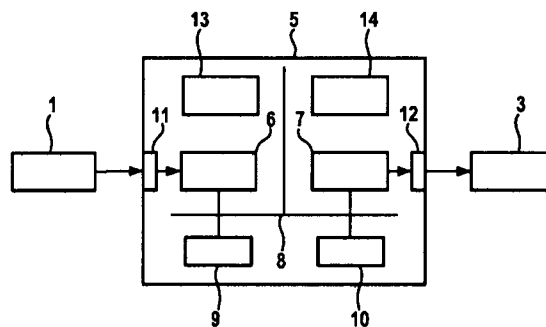


Fig. 2

I/We claim:

1. A method for processing information and activities in a technical control and/or regulating system, wherein technical control and/or regulating tasks are performed by a microcontroller (5), and wherein the technical control and/or regulating system comprises various components (1, 3) and the microcontroller (5) comprises information evaluated and processed by the same, and outputs at least one output signal as a result of technical control and regulating calculations, the method comprises:

dividing the technical control and/or regulating tasks of the technical control and/or regulating system into component-specific task complexes; and

processing a first component-specific task complex by a first computer core (6) of the microcontroller (5) and processing a second component-specific task complex by a second computer core (7) of the microcontroller (5);

characterized in that,

the first component-specific task complex comprises reading and/or processing of information of a sensor (1) by the first computer core (6) and the second component-specific task complex comprises controlling and/or regulating an actuator (3) by the second computer core (7).

2. The method as claimed in claim 1, wherein the method further comprising the processing of the first component-specific task complex by the first computer core (6) is carried out simultaneously with the processing of the second component-specific task complex by the second computer core (7).

3. The method claimed as claimed in claim 2, wherein the method further comprises processing a third component-specific task complex by a third computer core (13) of the microcontroller (5), wherein the third component-specific task comprises evaluating the sensor information processed by the first computer core (6) and performing the technical control and/or regulating calculations, output values of which are provided to the second computer core (7) for controlling the actuator (3).

4. The method as claimed in claim 3, wherein the method further comprises simultaneously implementing data exchange by the first computer core (6) and/or the second computer core (7) and/or the third computer core (13) with at least one memory unit (9, 10) via a communication system (8).

5. The method as claimed in one of the preceding claims 3 to 4, wherein the method further comprises carrying out a progress formation of an actuation signal of the actuator (3) during actuation of the actuator (3) on the basis of simultaneously read sensor information.

6. The method as claimed in one of the preceding claims, wherein the method further comprise carrying out an error detection mechanism of the first computer core (6), the second computer core (7), and third computer core (13), independently of a path of the controlling and/or regulating.

7. The method as claimed in claim 6, wherein the method the error detection mechanism is processed by a fourth computer core (14) of the microcontrollers (5).

8. The method as claimed in claim 1, wherein the technical control and/or regulating system is a motor vehicle system.

9. A device for processing information and activities in a technical control and/or regulating system, wherein technical control and/or regulating tasks are performed by a microcontroller (5), wherein the technical control and/or regulating system comprises various components (1, 3) and the microcontroller (5) comprises information that is evaluated and processed by the same, and outputs at least one output signal as a result of technical control and regulating calculations, the device comprises:

means (5) for dividing the technical control and/or regulating tasks of the system into component-specific task complexes, wherein a first component-specific task complex is processed by a first computer core (6) of the microcontroller (5) and a second component-specific task complex is processed by a second computer core (7) of the microcontroller (5);

characterized in that,

the first component specific task complex comprises reading and/or processing of information of a sensor (1) by the first computer core (6), and the second component-specific task complex comprises controlling and/or regulating an actuator (3) by the second computer core (7).

10. The device as claimed in claim 9, wherein the first computer core (6) is connected to a sensor (1) via a first interface (11) and the second computer core (7) is connected to the actuator (3) via a second interface (12).

11. The device as claimed in claim 10, wherein the technical control and/or regulating system comprises a communication system (8) that connects both the first computer core (6) and the second computer core (7) simultaneously with at least one memory unit, in particular a random access memory (9) or a read only memory (10).

12. The device as claimed in claim 11, wherein the microcontroller comprises a third computer core (13) for an evaluation of the information of the sensor processed by the first computer core (13) and for performing the technical control and/or regulating calculations, and wherein the third computer core (13) outputs an output value to the second computer core (7) for controlling the actuator (3), and wherein the microcontroller comprises a fourth computer core (14) for an error detection mechanism of the technical control and/or regulating system.

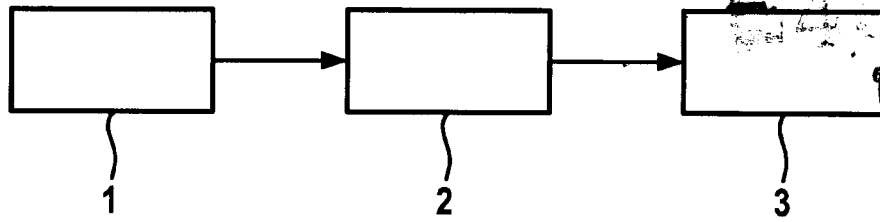
**Dated this 16<sup>th</sup> day of January 2012**



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**AGENT FOR THE APPLICANT**

**To  
The Controller of Patents  
The Patent office at New Delhi**



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6 JAN 2012

Fig. 1

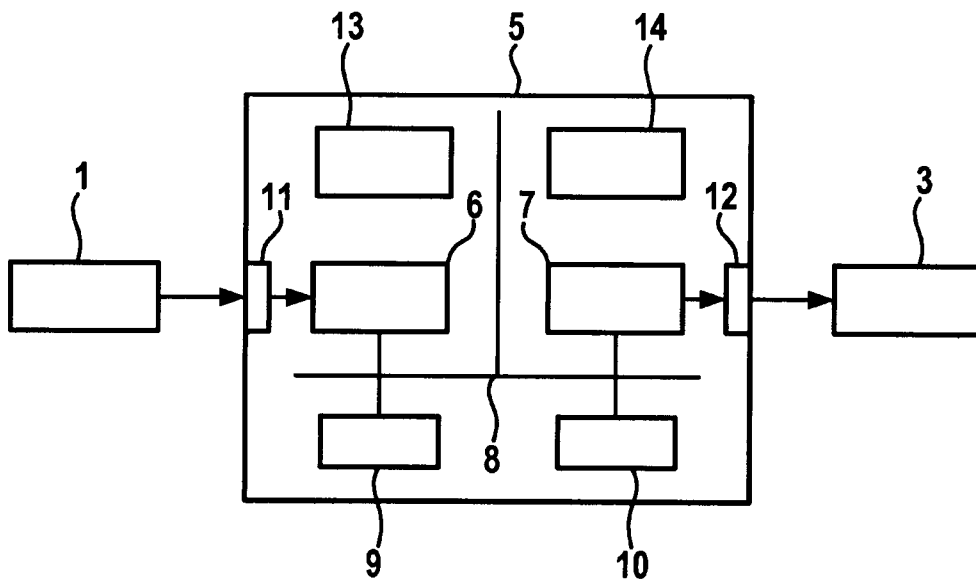


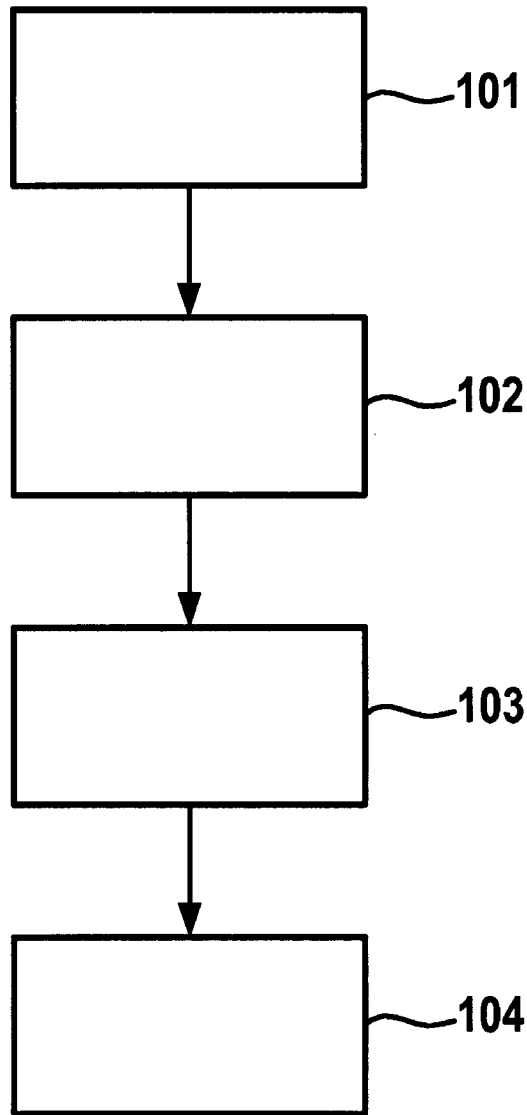
Fig. 2

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**Fig. 3**

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## TECHNICAL FIELD

The present subject matter relates to a method for processing information and activities in a technical control and/or regulating system and, in particular, to such systems in which technical control and/or regulating tasks is performed by a microcontroller.

## BACKGROUND

In conventional technical control and/or regulating systems, for example, as used in a motor vehicle, a variety of electronic components are used for control and/or regulation purpose. The electronic components usually include components such as one or more sensors, a processing unit, and at least one actuator. To process information of the sensor and calculate actuation commands for the actuator, microcontrollers that are built into a control unit are used. While using only one microcontroller, due to the limited computing power of the microcontroller, either the sensor or actuator values can be read and evaluated or computed at a time.

A method of processing information and activities, particularly resulted during the controlling of the internal combustion engines are known from DE 40 04 516 A1. The known method works with two controllers installed in a control unit. The resulting computationally intensive processing of different levels of information and activities run independently by the two controllers. A time-synchronous level is operated by one of the first controller and an angle synchronous level by a second controller. With increasing functionality, the number of controllers also increases, which has a consequence of costly control unit.

## SUMMARY

This summary is provided to introduce concepts related to a method for processing information and activities in a technical control and/or regulating system using a multicore processor and the concepts are further described below in the detailed description. This summary is neither intended to identify essential features of the claimed subject matter nor is it intended for use in determining or limiting the scope of the claimed subject matter.

In one embodiment, a method for processing information and activities in a technical control and/or regulating system is disclosed. Technical control and/or regulating tasks are performed by a microcontroller. The technical control and/or

regulating system includes various components. The microcontroller includes information that is evaluated and processed by the same, and outputs at least one output signal as a result of technical control and regulating calculations. In one implementation, the method includes dividing the technical control and regulating tasks of the system into component-specific task complexes, where a first component-specific task complex is processed by a first computer core of the microcontroller and a second component-specific task complex is processed by a second computer core of the microcontroller. The first component-specific task complex includes reading and/or processing of information of a sensor by the first computer core and the second component-specific task complex includes controlling and/or regulating an actuator by the second computer core.

In another embodiment, a device is disclosed for processing information and activities in a technical control and/or regulating system.

#### BRIEF DESCRIPTION OF DRAWINGS

The present subject matter permits numerous embodiments. One of them will be illustrated by the following figures. The same features are denoted by identical reference numerals in the figures, wherein:

Fig. 1 shows a schematic representation of a typical technical control and/or regulating system.

Fig. 2 shows a schematic diagram of a device for processing information and activities in a technical control and/or regulating system, according to an embodiment of the present subject matter.

Fig. 3 shows a schematic flow diagram for the method for processing information and activities in a technical control and/or regulating system.

#### DETAILED DESCRIPTION

The present subject matter aims to provide a method and a device for processing information and activities in a technical control and/or regulating system, which is realized in a cost-effective manner and still has a high computing power.

According to the present subject matter, the technical control and regulating tasks of the system are divided into component-specific task complexes, whereby a first component-specific task complex is performed by a first computer core of the microcontroller and a second component-specific task complex by a second computer

core of the microcontroller. An advantage of the present subject matter consists in the fact that by using a multi-core microcontroller, an effective form of decoupling of the technical control and/or regulating tasks of the system is resulted. In this way, a high effective computing performance is achieved, because each computer core at a predetermined time processes different types of tasks. Thus, the computing power of the microcontroller is utilized effectively. The use of several microcontrollers can be thus waived off.

In an implementation, the processing of the first component-specific task complex by the first computer core is performed simultaneously with the processing of the second component-specific task complex by the second computer core. By the simultaneous processing of different component-specific task complexes on different computer cores of a microcontroller, a technical system parallel of the complete task is carried out, whereby the complexity of the processes on the microcontroller is also reduced.

In one embodiment, the first component-specific task complex includes reading and/or processing of information of a sensor by the first computer core and the second component-specific task complex includes control and/or regulating an actuator by the second computer core. The component-specific task complex is based on the component, which are located external to the microcontroller, such as sensor and actuator. Since the evaluation of sensory information is often very complex, the actuator controlling by the method as described herein waits no more up to the conclusion of the evaluation of the sensor information because the computer core reads and/or evaluates the information of the sensor, while on the other computer core the control signal for the actuator is calculated.

In another implementation, a third component-specific task complex exists in a processing process performed by a third computer core of the microcontroller, in which the sensor information processed by the first computer core is evaluated and the technical control and/or regulating calculations are performed, output values of which are outputted to the second processing unit for controlling the actuator. The processing process solves a technical control task, whereby the result of the task is to provide an output data for the actuator. Since the task can take a very complex shape, it is considered as a separate component-dependent task, which is processed on a separate computer core, leading to further decoupling of the complexity of the microcontroller. The computing power is increased by the use of a third computer core. The number of computer cores that can be efficiently used by these tasks depends and can be distinguished as many component-

specific task complexes in the technical control and/or regulating system. Thus, the computational performance of the system is further increased and the parallelism of the execution/processing of the tasks are improved.

In one implementation, the first and the second and/or third computer core simultaneously implements exchange data with at least one memory unit via a communication system of technical control and/or regulating system. The parallel processing is limited within the microcontroller not only on the processing by the computer cores, but also refers to the communication system, which can be configured as a bus, crossbar, or micro-controller-internal communication system. This ensures that at least two computer cores can simultaneously access the memory. Also, a bus processing does not lead to sequencing.

In one implementation, a course forming of a control signal of the actuator takes place during its controlling/activation on the basis of the sensor information scanned simultaneously. Because the sensor signals in the first computer core is evaluated by the second computer core parallel to determination of the actuator signals, the actuator signal to the current sensor value can be directly adjusted, which as a result has a very precise shaping of the actuator control function. This is only possible because through the processing of tasks on different computer cores, a high computer performance is present.

In one implementation, an error detection mechanism of the first, the second or the third computer core functions independent from the path of the control and/or regulation. Through the separation of control and/or regulation and monitoring, it is thus possible to realize the implementation of the technical control and/or regulation tasks very quickly, very accurately and thus with improved error coverage.

In one implementation, the error detection mechanism is processed by a further, for example, fourth computer core of the microcontroller. Through the use of the fourth computer core, the monitoring path is across components and independent of the path to be controlled. Thereby, a plurality of sensors and multiple actuators are monitored simultaneously.

In one implementation, the technical control and/or regulating system represents a motor vehicle. The method as described herein can be used for motor vehicles, where numerous highly complex technical control and/or regulation tasks such as steering, braking or damping are to be processed, which individually require a high performance computing. The use of a multi-core controller for each one of these mentioned control and/or regulating complex cheapens the construction of a control device.

A further embodiment of the present subject matter relates to a device for processing information and activities in a technical control and/or regulating system, in which technical control and/or regulating tasks are performed by a microcontroller. The technical control and/or regulating system is made of various components and the microcontroller includes information that is evaluated and processed by the same, and at least one output signal is output as the result of technical control and/or regulating calculations. To indicate a device for processing of information and activities in a technical control and/or regulating system, which is manufactured in a cost effective manner and yet has a high computing power, means for dividing the technical control and/or regulating tasks of the system into component-specific task complexes are provided. Here, a first component-specific task complex is processed by a first computer core of the microcontroller and a second component-specific task complex is processed by a second computer core of the microcontroller. This has the advantage that the software-based summary of component-dependent task complexes results in an effective form of decoupling of the technical control and/or regulating tasks of the system. In addition, a high computing performance is achieved as each computer core processed at a given time processes a different type of task. By using a multi-core, the computing power of the microcontroller is used effectively, whereby the use of several microcontrollers can be waived off.

In one implementation, the first computer core is connected to a sensor via a first interface and the second computer core is connected to an actuator via a second interface. The direct connection of the computer cores with external components of the technical control and/or regulating system allows a structurally simple connection of the microcontroller.

In one implementation, the technical control and/or regulating system has a communication system, which connects both the first computer core as well as the second computer core simultaneously with at least one storage unit, especially a random access memory (RAM) or a read only memory (ROM). This ensures that at least two computer cores can simultaneously access the memory. The parallelism of the communication system is in turn prevents a sequencing of the signal to be transmitted.

In one implementation, the microcontroller includes a third computer core for analysis of the sensor information processed by the first computer core and the execution of the technical control and/or regulating calculations, whose output values can be outputted to the second computer core to control the actuator and/or a fourth computer

core for the error detection mechanism of the system. Depending on a number of complex tasks to be processed in parallel, a multi-core controller having the required number of computer cores is selected, as different cores are required for the processing of different complex tasks simultaneous in parallel.

Fig. 1 shows a motor vehicle with a typical technical control and/or regulating system as its principal components is shown. The system includes a sensor element 1 that supplies information to a processing unit 2. The processing unit 2 processes the information or data supplied by the sensor element 1, analyzes it, and calculates output data that is sent to an actuator 3. The sensor element 1 may provide analog or digital values. These values can be supplied to the processing unit 2 via A/D (analog-digital) channels via a bus system or a dedicated sensor interface.

The sensor element 1 may measure a current or voltage value, a position or an angle, and a pressure or a moment, etc. In a real-time system, as it represents the vehicle, the task of reading sensor values and their processing is very costly. This is partly because the sensor values must be updated very often. On the other hand, more and subsequent processing is necessary, which may consist, for example, averaging, filtering, smoothing or a plausibility check.

The processing of sensor data processed by the processing unit 2 exists frequently in the solution of technical control task, but can also have different algorithmic foundations. As a result, the processing of sensor data provides output data for the actuator 3.

The controlling of the actuator 3 represents a complex task. For example, this exists with an injection of the combustion engine from several different individual injections, which can also be configured differently.

Fig. 2 shows a system having a multi-core microcontroller 5, according to an embodiment of the present subject matter. The multi-core microcontroller 5 has four computer cores 6, 7, 13 and 14. The computer cores 6, 7, 13, 14 are connected to each other and to a random access memory (RAM) 9 and a read only memory (ROM) 10, via an internal communication system 8. The sensor element 1 leads to the first computer core 6 via a first interface 11, while the second computer core 7 leads to the actuator 3 via a second interface 12.

The internal communication system 8 is so configured that multiple computer cores 6, 7, 13, 14 allow simultaneous access to the ROM 10 and/or the RAM 9.

The sequence of the method which the present subject matter defines is described with reference to Fig. 3. In block 101, the computer core 6 reads a sensor value via the interface 11 and performs sensor data detection and processing. The processed sensor data is provided in block 102 via the internal communication system 8 to other computer cores, for example, the computer core 13, which uses the sensor data to solve a technical problem and determines output data for the actuator 3. This output data is again provided to other computer cores via the internal communication system 8. For example, the computer core 7 can determine data available for processing from the control parameters for the actuator 3, and this controls via the interface 12 (block 103).

In block 104, the processes in the computer cores 6, 7 and 13 and in the sensor element 1 as well as the actuator 3 are monitored by the computer core 14, in which an error detection mechanism is stored. This error monitoring is thus carried out independent of the computer cores 6, 7, 13, which are concerned with the technical control and/or regulating tasks.

The method can be used with more or even less computer cores. If, for example, the processing step is very simple, this can be assumed by the computer core 6 or 7. It is then still possible to parallelize actuator controlling and sensor processing.

If no independent error monitoring is necessary, an appropriate computer core 14 can be waived off, so that the core of the process can be represented even on a two-computer core system. If multiple sensors play a role in the system, these sensors can be read on a computer and use processing core 7 or more computer cores (for example, one per sensor).

One useful application of the method can be realized on two computer cores for monitoring purposes. One of the two cores takes in this case the controlling of an actuator, for example, an injection system or an electric motor. In many applications, which are implemented on embedded systems (for example, in the motor vehicle), it is important to monitor this activation, that is, to ensure that the desired result of the controlling actually adjusts well. In an embodiment, it is monitored, via a sensor that measures this result, whether the acting chain is functioning correctly by the controlling up to the control actuators. Technically, in a system with sensors, the result is measured as directly as possible; however, it is often necessary to compute the result over a model from the measured values. It may therefore also require a considerable computational effort to calculate such outcome. Thus, it is advantageous even for performance reasons to use the present method and sensor evaluation, and this may also carry out the

comparison with the desired result on the second core. Also, there are safety reasons to use the present method, since the second core is an independent assessment of the acting chain, which operates via the first core. In such a case, if by appropriate hardware measures, such as an exclusive access to the sensor interface is ensured such that only the second core directly receives the sensor values, then the independence at the system level is even more pronounced. The application of the method has technical safety also and has a shorter time error detection, since the real-time monitoring runs parallel. Thus, it is possible to respond to react suitably even for small deviations, as, for example, a message is sent from the monitoring core to the acting core, and thus early countermeasures can be taken. This extension makes it possible even for an increased availability.

In another implementation of the present method, the results of computer cores are (all or individual) written in the memory 9 via the communication system 8, and then have the access to the other computer cores.

Especially in a periodic system this procedure can be used, for example, if a computer core is used in a cycle data, which is calculated from the other computer cores in the previous cycle.

Even if two processes are executed in parallel, this method can be used. For example, if current sensor values are considered for the controlling of an actuator, the present method may be used to implement the parallelism. These can then be used to represent a high temporal resolution during formation of a controlling signal or to implement an accurate monitoring.

In the vehicle there are a variety of potential applications for the present subject matter. If the injection is used as actuators in a vehicle system, whereby the actuators 3 represent the multiple injection nozzles, a plurality of sensor elements are necessary to properly adjust the actuator. Thereby, for example, the rail pressure, the combustion chamber pressure in the cylinders, the exhaust gas temperature and the lambda factor are measured as the sensor data.

In a brake system either a valve or an electric motor is used as an actuator 3. For proper control of these actuators, the brake pressure and wheel speeds are detected.