Claims

1. Device for acoustic monitoring of a monitoring area, comprising:

a first sensor system comprising a first acoustic sensor, a first processor, and first transmission means, which system may be mounted at a first location of the monitoring area;

a second sensor system comprising a second acoustic sensor, a second processor, and second transmission means, which system may be mounted at a second location of the monitoring area that is different from the first location,

wherein the first processor is configured to classify a first audio signal detected by the first acoustic sensor so as to obtain a first classification result,

wherein the second processor is configured to classify a second audio signal detected by the second acoustic sensor so as to obtain a second classification result,

wherein the first transmission means is configured to transmit the first classification result to a central evaluation means,

wherein the second transmission means is configured to transmit the second classification result to the central evaluation means,

the central evaluation means, the central evaluation means being configured to receive the first classification result and to receive the second classification result, and to generate a monitoring output for the monitoring area as a function of the first classification result and the second classification result;

wherein the first transmission means is configured to transmit a first signal to the central evaluation means only if the first classification result matches a first predetermined classification result;

wherein the second transmission means is configured to transmit a second signal to the central evaluation means only if the second classification result matches a second predetermined classification result; and

wherein the central evaluation means is configured to count, on the basis of the first signal, how many times, per time interval, the first sensor system has determined the first predetermined classification result, or to count, on the basis of the second signal, how many times, per time interval, the second sensor system has determined the second predetermined classification result.

2. Device as claimed in claim 1, wherein the first acoustic sensor is configured to measure a first level of the first audio signal; and

wherein the first transmission means is configured to transmit the first level to the central evaluation means.

~~3. Device as claimed in claim 2,~~

~~wherein the second acoustic sensor is configured to measure a second level of the second audio signal;~~

~~wherein the second transmission means is configured to transmit the second level to the central evaluation means; and~~

~~wherein the central evaluation means is configured, when the first classification result matches the second classification result, to spatially locate a source of the first audio signal and of the second audio signal in the monitoring area as a function of the first level and of the second level while using information about the first location and information about the second location.~~

4~~3~~. Device as claimed in claim 2~~ or claim 3~~, wherein the central evaluation means is configured, when an upper limit value is exceeded by the first level, to indicate this exceeding in the monitoring output.

5~~4~~. Device as claimed in any of claims 1 to 4~~3~~, wherein the first audio signal detected by the first acoustic sensor is a superposition of at least two sound events; and

wherein the first processor is configured to apply a source separation algorithm to the first audio signal to classify the at least two sound events or to obtain a first

source signal and a second source signal which represent the at least two sound events so as to classify the first source signal and the second source signal.

~~6~~5. Device as claimed in any of claims 1 to ~~5~~4, wherein the first classification result and the second classification result are configured to indicate used appliances in the monitoring area, activities in the monitoring area, volume levels in the monitoring area, phases of a process in the monitoring area, or a match of at least a portion of the first audio signal or of the second audio signal with a predetermined classification result.

~~7~~6. Device as claimed in any of claims 1 to ~~6~~5, wherein the first processor is configured to convert the first audio signal detected by the first acoustic sensor to a time/frequency representation; and

wherein the first processor is configured to classify the first audio signal while using the time/frequency representation so as to obtain a first classification result.

~~8~~7. Device as claimed in any of claims 1 to ~~7~~6, wherein the first transmission means is configured to transmit the first classification result comprising first local or temporal information to the central evaluation means; and

wherein the central evaluation means is configured to generate the first classification result in conjunction with the first local and temporal information as a monitoring output for the monitoring area.

~~9. Device as claimed in claim 8, wherein the central evaluation means comprises:~~

~~a memory for storing a predetermined process sequence comprising a series of activities in the monitoring area,~~

~~a processor for arranging the first classification result and the second classification result in an order defined by spatial or temporal information about the first sensor system or the second sensor system, wherein the first classification result and the second classification result indicate the activities in the monitoring area;~~

~~for comparing the predetermined process schedule plan with the arranged first and second classification results; and~~

~~for generating a monitoring output as a function of a result of the comparison.~~

~~10. Device as claimed in claim 9, wherein the monitoring output indicates a difference between the predetermined process schedule plan and the arranged first and second classification results.~~

~~11~~8. Device as claimed in any of claims 1 to ~~10~~7, wherein the first sensor system or the second sensor system is configured to continuously detect a first audio signal by using the first acoustic sensor so as to classify the first audio signal in the first processor within a first maximum time period, said first maximum time period being shorter than five seconds, and wherein the first transmission means is configured to transmit the first classification result to the central evaluation means within a second maximum time period, said second maximum time period being shorter than five seconds.

~~12~~9. Device as claimed in any of claims 1 to ~~11~~8, wherein the first transmission means, the second transmission means and the central evaluation means are configured to wirelessly communicate with each other in accordance with a mobile radio protocol.

~~13~~10. Device as claimed in any of claims 1 to ~~12~~9, wherein the first sensor system is configured to obtain the first classification result at a first point in time and at a second point in time by means of the first processor and to transmit it to the central evaluation means by means of the first transmission means; and

wherein the central evaluation means is configured to order and indicate the first classification result of the first point in time and the first classification result of the second point in time as a function of the first point in time or of the second point in time.

~~14~~11. Device as claimed in any of claims 1 to ~~13~~10, wherein the first classification result or the second classification result is a classification result for a construction site event, the construction site event being formed as a group comprising a tool noise, a hammering noise, a sawing noise, a drilling noise, a pneumatic hammering noise,

a measuring device noise, a machine noise, a burden chain noise, a concrete mixing noise, a concrete casting noise, an excavator noise, a roller noise, a material unloading noise, a tear-down noise or a scaffolding noise.

~~15~~12. Device as claimed in any of claims 1 to ~~14~~11, wherein the first acoustic sensor is configured to detect the first audio signal;

wherein the first acoustic sensor is configured to measure a first level of the first audio signal; and

wherein the first acoustic sensor is configured to switch the first processor or the first transmission means from a sleep mode to an operating mode only when a lower limit value for the first level is exceeded, and

wherein the first processor is configured to determine the first classification result or the second classification result only in the operating mode, or

wherein the first transmission means is configured to perform transmission only in the operating mode, and

wherein the first transmission means or the first processor are configured to consume less power in the sleep mode than in the operating mode.

~~16~~13. Device as claimed in any of claims 1 to ~~15~~12, wherein the first acoustic sensor is configured to detect the first audio signal;

wherein the first acoustic sensor is configured to measure a first level of the first audio signal; and

wherein the first acoustic sensor is configured to set the first processor or the first transmission means so that the first classification result will be determined by the first processor and be transmitted to the central evaluation means by means of the first transmission means if the first level is higher than a lower limit value, and so that no first classification result will be determined by the first processor and be transmitted to the central evaluation means by means of the first transmission means if the first level is lower than or equal to the lower limit value.

~~17~~14. Device as claimed in any of claims 1 to ~~16~~13, wherein the first sensor system or the second sensor system is battery- or accumulator-operated.

~~18~~15. Device as claimed in any of claims 1 to ~~17~~14, wherein the first transmission means is configured to transmit to the central evaluation means an identification of the first sensor system together with the first classification result;

wherein the second transmission means is configured to transmit to the central evaluation means an identification of the second sensor system together with the second classification result;

wherein the central evaluation means comprises a memory, the memory comprising an association of the identification of the first sensor system with the first location and an association of the identification of the second sensor system with the second location;

wherein the central evaluation means is configured to determine the first location on the basis of the identification of the first sensor system from the memory and to determine the second location on the basis of the identification of the second sensor system from the memory; and

wherein the central evaluation means is configured to spatially locate, in the monitoring region, a first source region of the first audio signal and a second source region of the second audio signal on the basis of the first location, the second location, the first classification result or the second classification result.

~~19~~16. Device as claimed in any of claims 1 to ~~18~~15, wherein the first transmission means is configured to transmit only the first classification result or a processed first audio signal to the central evaluation means; and

wherein the second transmission means is configured to transmit only the second classification result or a processed second audio signal to the central evaluation means.

~~20~~17. Device as claimed in claim 1,

wherein the first predetermined classification result and the second predetermined classification result is a classification result for a vehicle;

wherein the monitoring area is a road, a road network or a rail network;

wherein the first sensor system or the second sensor system may be mounted to roads or rails,

wherein the central evaluation means is configured to provide capacity utilization of the monitoring area per location or per group of locations.

~~21~~18. Device as claimed in any of claims 1 to ~~20~~17, wherein the monitoring area is a construction site, a factory building with machines, a machine, or an inhabited place or part of an inhabited place.

~~22~~19. Method of acoustic monitoring of a monitoring area, comprising the following steps:

mounting a first sensor system comprising a first acoustic sensor, a first processor and first transmission means at a first location of the monitoring area;

mounting a second sensor system comprising a second acoustic sensor, a second processor and second transmission means at a second location of the monitoring area, which is different from the first location,

classifying a first audio signal detected by the first acoustic sensor by using the first processor to obtain a first classification result;

classifying a second audio signal detected by the second acoustic sensor by using the second processor to obtain a second classification result;

transmitting the first classification result to a central evaluation means on the part of the first transmission means;

transmitting the second classification result to the central evaluation means on the part of the second transmission means;

receiving the first classification result and the second classification result on the part of central evaluation means; and

generating a monitoring outputfor the monitoring area as a function of the first classification result and the second classification result on the part of the central evaluation means,

wherein a first signal is transmitted to the central evaluation means only if the first classification result matches a first predetermined classification result;

wherein a second signal is transmitted to the central evaluation means only if the second classification result matches a second predetermined classification result; and

counting, on the basis of the first signal, how many times, per time interval, the first sensor system has determined the first predetermined classification result, or counting, on the basis of the second signal, how many times, per time interval, the second sensor system has determined the second predetermined classification result.

~~23~~20. Computer program comprising a program code for performing the method as claimed in claim ~~22~~19, when the program runs on a computer.

~~24. Device for acoustic monitoring of a monitoring area, comprising:~~

~~a first sensor system comprising a first acoustic sensor, a first processor, and first transmission means, which system may be mounted at a first location of the monitoring area;~~

~~a second sensor system comprising a second acoustic sensor, a second processor, and second transmission means, which system may be mounted at a second location of the monitoring area that is different from the first location,~~

~~wherein the first processor is configured to classify a first audio signal detected by the first acoustic sensor so as to obtain a first classification result,~~

wherein the second processor is configured to classify a second audio signal detected by the second acoustic sensor so as to obtain a second classification result,

wherein the first transmission means is configured to transmit the first classification result to a central evaluation means,

wherein the second transmission means is configured to transmit the second classification result to the central evaluation means,

the central evaluation means, the central evaluation means being configured to receive the first classification result and to receive the second classification result, and to generate a monitoring output for the monitoring area as a function of the first classification result and the second classification result;

wherein the first audio signal detected by the first acoustic sensor is a superposition of at least two sound events; and

wherein the first processor is configured to apply a source separation algorithm to the first audio signal to classify the at least two sound events or to obtain a first source signal and a second source signal which represent the at least two sound events so as to classify the first source signal and the second source signal.