

**A pest control device for recognizing pest, a pest control system and a method
for recognizing pest by running the pest control system**

Technical field

The present disclosure relates generally to pest control, in particular to
5 recognizing pest species or a subgroup thereof. More specifically, the disclosure
relates to a pest control device for recognizing pest, a pest control system and a
method for recognizing pest by running the pest control system as defined in the
introductory parts of the independent claims.

Background art

10 In most cities in the world the presence of rodents, in particular rats, is a
problem. As the cities and the population in the cities grow, the problem becomes
larger. Even though pest control has developed immensely during the last decades,
severe damages are still today caused by rodents. The damages are not only direct
damages, e.g. food or crops being eaten by rodents, but also indirect damages
15 causing sanitary issues for households or business as well as spreading of diseases.
Having reliable and efficient pest control is therefore important from a wide range of
aspects.

Insects may also cause problems. Problems associated with insects range from
being a nuisance to causing tangible damages, for instance, by spreading diseases,
20 ruining food or crops, destroying clothes, furniture, or even building materials. As a
result, property, buildings or other living spaces may become uninhabitable. To date,
there has especially been a need for developing pest control for mosquitoes,
cockroaches, bedbugs and flies, but the increased globalization leads to higher risk of
global spreading of other harmful insects.

25 New and improved methods for pest control are consequently being developed
on an ongoing basis, a great deal of which is based on insecticides, pesticides, while
other methods use actual traps, containing mechanical and/or electric means for pest
control.

During the last few years, digitally connected pest control devices have become
30 increasingly popular. For instance, the SMART solutions developed and marketed by

Anticimex™ is one example well-known in the industry of pest control. By having pest control devices and sensors for monitoring that are connected to the Internet, improved monitoring of pest is made possible. This has the advantage that the need for manually checking the pest control devices is reduced or in some cases completely removed.

- 5 The workload for an operator monitoring or operating the pest control devices may thereby be reduced. To this end, interconnected pest control devices may allow for a more accurate and robust pest control.

- Although pest control devices and systems of pest control devices are improving, there is still a need for further development. By way of example, there is a need for even earlier and more precise detection of pest. This as early detection of a pest enables faster responses and more successful outcomes in the pest control. It may, however, be challenging to attract or lure pest to a pest control device as behavioural resistance developed by the pest may make them avoiding new objects and/or other changes to the surrounding. To allow for more efficient monitoring and/or trapping of pest there is further a need for improved identification of the type of pest that is present at a given location. There is therefore also a need for improved tracking of the identified pest as this may allow for more accurate analysis and forecasts regarding, for instance, pest population growth, migration and/or behavioural patterns of the pests. Damages associated with the presence of pest may thereby be reduced.
- 10 15 20 The spreading of pest may even be prevented by use of specific and efficient pest control devices such as monitoring devices and trap devices having such capabilities.

Summary

- It is an object of the present disclosure to mitigate, alleviate or eliminate one or more of the above-identified deficiencies and disadvantages in the prior art and solve at least the above-mentioned problem.
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According to a first aspect there is provided a pest control device for recognizing pest, comprising:

- a housing;
- a processor;
- 30 a memory;

a data communication device configured to communicate with a gateway or another pest control device;

a sound recording device configured to record one or more sound patterns; wherein the processor is configured to perform a recognition process identifying a pest species or a subgroup thereof based on the recorded one or more sound patterns by a comparison with a selection of sound patterns in the memory or in a remote memory, wherein each sound pattern corresponding to the pest species or the subgroup thereof.

An advantage with the pest control device above is that this allows for efficient identification of a pest species or a subgroup thereof. The amount of data needed for identifying the pest species is further reduced. Put differently, the size of the data needed for the identification may be reduced. By way of example, data pertaining to a sound pattern may be smaller in size compared to, for instance image data. A further advantage being that the pest control device may be less sensitive to light conditions when detecting pest. The pest control device may identify pest even in darkness. Costs associated with manufacturing the pest control device may further be reduced.

An improved identification of a subgroup of a pest species may further be obtained. By way of example, age, gender, and/or individual of a pest species may be recognized. As an effect, a more efficient counting of pest may be obtained. It may therefore be possible to distinguish between different individuals and/or subgroups of a pest species allowing for an improved detection and analysis of the occurrence of pest. Improved monitoring and/or prediction of population growth may thereby be obtained.

A sound pattern generated by a pest may be understood as a characteristic of a sound produced by the pest. The sound pattern may be represented by a sound recording of a sound generated by the pest. The sound may be characteristic for a pest species or a subgroup thereof. The sound may be a vocalization. By way of example, the sound may be a high-pitched squeak and chirp used for communication between e.g. rodents. By way of example, the sound may be a communication sound. The sound may alternatively be a humming, whirring, and/or swarming. The sound may alternatively be generated by the movement of the pest. The sound may be a beating of a leg and/or a wing of the pest. The sound may alternatively be generated by the pest in a certain situation or be associated with a specific behaviour. The sound may, by way of example, be a result of the pest walking, crawling, flying, and/or

scratching. The sound may be caused by the pest eating. Further, the sound may be generated collectively by a number of pest, such as pests in a swarm or a flock. The sound pattern may comprise a characteristic of a sound, by way of example, spectral components of the sound. For instance, the sound pattern may be a sound spectrum.

- 5 The sound pattern may be defined as a mathematical representation of the sound. Further, the sound pattern may comprise a single sound attribute or a plurality of sound attributes. The one or more sound attributes may comprise at least one of a frequency, a rhythm, amplitude, a melody, and sound spectrum. The sound pattern may be a sound sequence. The sound pattern may be understood as a "fingerprint" of
10 a sound generated by the pest. The sound pattern may be in the form of audio data.

The recorded sound pattern may be understood as data pertaining to the recorded sound from a pest species. The sound pattern may be referred to as sound pattern data.

- According to some embodiments, the pest control device may be configured to
15 save the recording of the one or more sound patterns and data pertaining to the identified pest species or subgroup thereof to the memory of the pest control device.

- An advantage of having the recorded sound patterns added to the memory is that local variations in the presence of pest may be adjusted for. Put differently, data pertaining to the presence of a pest species or a subgroup thereof at the geographical
20 location of the pest control device may be recorded. A more versatile pest control device may hence be provided. An increased register or database of sound patterns may be achieved. Put differently, recorded sounds may be added to the memory allowing for improved identification of pest or subgroups thereof. By way of example, geographical variations of a sound pattern pertaining to a pest species of a sub-
25 species thereof may be added to the memory.

According to some embodiments, the pest control device may be configured to, by the data communication device, transmit data pertaining to the recording of one or more sound patterns and/or the identified pest species or a subgroup thereof to another pest control device and/or to the gateway.

- 30 An advantage of this is that information on the sound pattern and/or the pest species recognized at one location may therefore be transferred to another location. An advantage of this is in turn that an improved recognizing of the pest species may be

obtained. By sharing information about the pest species and even individuals between pest control devices at different locations, an improved identification and/or tracking of the pest species may be achieved. Put differently, pests identified at one location may easier be identified at another location. In other words, a pest species or a subgroup thereof that is identified at one location by a pest control device may more efficiently be identified at another location by another pest control device. Another positive effect of the sharing between the pest control devices is that a more versatile pest control system can be provided. Since information is shared, the pest control devices can be set up to detect a wide range of different species and also quickly be adapted to meet new demands related to new species infesting the environment in which the pest control devices are placed. The need of stored data pertaining to sound patterns and/or identified pest species may also be reduced. In other words, fewer sound recordings may initially be stored in the memory or remote memory.

The data transmitted may comprise one or more sound patterns. Put differently, the data transmitted may comprise a recording of a sound pattern or at least a part thereof. The data may be added to a memory of another pest control device. The data may comprise information about the pest species or an individual thereof. The data may comprise a pointer to a pest species in a list of different pest species. A more comprehensive selection of sound patterns in the memory may be built up. The accuracy of recognizing a pest species or a subgroup thereof may be increased. The set up and/or configuration of a plurality of pest control devices may be less complex and time demanding. The work of an operator installing a plurality of pest control devices may be simplified.

According to some embodiments, the pest control device may comprise a camera arranged to record imaged data of the pest; wherein the image data of the pest is stored on the memory; and wherein the identification made in the recognition process is further based on a combination comprising the image data and the recorded one or more sound patterns.

An advantage being that a more accurate recognition may be provided. Subgroups and/or individual pest may further be identified. Data pertaining to sound patterns of subgroups and/or individual pest may therefore be provided. The number of different pests that may be recognized by the pest control device may further be increased. A more versatile pest control may thereby be provided. An efficient

matching of the one or more sound patterns to the pest species or the subgroup thereof may be provided.

According to some embodiments, the pest control device may be configured to initiate tracking of a pest by identifying an individual-specific sound pattern for the pest
5 and send the individual-specific sound pattern to another pest control device.

An advantage being that individual pest may be identified and tracked. Data pertaining to sound pattern of an individual pest may be transferred to another pest control device such that the another pest control device may recognize the individual pest. A more efficient tracking of the pest as it moves from one location to another
10 location may be obtained. By way of example, the individual pest may be distinguished from other individuals allowing for improved analysis of pest population growth and pest movement. By way of example, an improved estimate of number of pests at a location or in a region may be determined.

According to some embodiments, the pest control device may comprise a
15 resonating chamber within the housing for amplifying a species-specific sound frequency range.

An advantage being that sound generated by the pest species may be amplified efficiently. The resonating chamber further allows for passive amplification. The passive amplification reduces the need of providing energy for amplification of sound. The
20 resonance chamber may be understood to use sound wave resonances to enhance the transfer of energy from a sound source, i.e. the pest to the air. The size of the chamber may be tuned to match a frequency range. The pest control device may comprise one or more resonating chambers. The one or more resonating chambers may differ in size. The one or more resonance chambers may be arranged to amplify
25 different frequency ranges. A further advantage is that sound signals pertaining to one of the plurality of resonating chambers may provide information on what pest species that is present.

According to some embodiments, the pest control device may comprise: at least one additional sound recording device; wherein the processor in combination with the
30 memory is configured to receive signals from the multiple sound recording devices, to link the signals to detection time points and to process the signals and the detection time points into sensor data sets; and wherein the pest control device is configured to

track pest within the pest control device by time resolved detection of a sound pattern from the multiple sound recording devices.

An advantage being that that the movement of pest within the pest control device may be determined. By way of example, the movement pattern within a pest control device may be determined. An improved understanding of how the pest perceive the pest control device may be achieved. The design of future pest control devices may, for example, be improved based on the gained understanding. Movement direction of a pest device may moreover be determined.

According to some embodiments, the housing may further comprise a vibration sensor arranged to vibrate in response to the pest moving across a surface of the housing; and detecting, by the vibration sensor, a vibrational pattern; wherein the recognition process is further based on the vibrational pattern.

An advantage being that the recognition of a pest may be improved. A combination of sound detected by the sound recording device and vibrations detected by the vibration sensor may be used for recognizing pest species or a subgroup thereof. Put differently, one or more combinations of a sound pattern and a vibration pattern may be used for recognizing the pest. By way of example, the vibrations detected may be a result of one or more pests moving, touching, crawling, and/or jumping on the vibration sensor. The vibration sensor may be arranged to form a surface or a surface portion of the housing of the pest control device. The surface or surface portion may be a floor, roof or wall surface. The vibration sensor may be in the form of a floor section. The vibration sensor may comprise different regions configured to vibrate in response to different vibration frequencies and/or vibration intensities.

The wording sound is here to be understood as vibrations generated by a source, e.g. a pest, that travels through a medium, e.g. air, to the sound recording device. The wording vibrations is here to be understood as oscillatory motion resulting from the application of oscillatory or varying forces to a structure, e.g. to the vibration sensor.

According to some embodiments, the pest control device may be configured to record and establish a base level sound of the surrounding and deducting the base level sound from the recorded sound pattern used for recognizing a sound pattern.

The pest control device may be configured to filter out background vibrations such vibrations caused by wind, traffic and/or human presence.

According to some embodiments, the recognition process based on the recorded at least one sound pattern may be further based on additional sensor data
5 regarding humidity, temperature, and/or presence of humans.

According to some embodiments, the pest control device may comprise multiple sound recording devices, each device being arranged to detect a specific sound frequency range different to the other sound recording devices. An advantage being that false detection events and/or misrecognition of a pest species may be reduced.

10 According to some embodiments, the pest control device may be a monitoring device arranged to allow the pest to pass and/or a trapping device arranged to capture the pest.

According to some embodiments, the pest species may be an insect species.

According to some embodiments, the pest species may be a mammal species.

15 According to a second aspect there is provided a pest control system comprising: multiple pest control devices according to the first aspect configured in a mesh network.

In line with the features and advantages presented above with respect to the first aspect, is that a pest control system is provided which allows for efficient
20 identification of a pest species or a subgroup thereof. Efficient communication between the pest control devices within the network may be provided. With this second aspect of the invention, similar advantages and preferred features are present when applicable as in the previously discussed first aspect of the invention.

According to some embodiments, a first pest control device may be configured
25 to transmit to a second pest control device the one or more recorded sound patterns and data pertaining to the recognized pest species or a subgroup thereof.

An advantage being that recorded sound patterns may efficiently be transferred and shared by one pest control device to another pest control device in the network of pest control devices. Put differently, data pertaining to a recorded sound pattern and
30 an associated identified pest may be sent from one pest control devices to another

pest control device within the mesh network. An improved recognition of the pest at the second pest control device may thereby be achieved. An advantage may be that the amount of work associated with installing and/or configuring a plurality of pest control devices may be reduced. The arrival of a new pest species and/or changes to the pest species at a location or within a region, e.g. due to climate and/or environmental changes, may more efficiently be accounted for. To this end, the information obtained may be transferred to another location or region. An improved accuracy in recognizing pest or a subgroup thereof may be provided. An improved monitoring and/or prediction of pest movement may further be achieved.

10 According to some embodiments, the pest control system may further comprise a gateway and remote or local server with recordings of sound patterns.

 According to some embodiments, the pest control system may be configured to track a pest by recognizing an individual-specific sound pattern at a first pest control device and send the individual-specific sound pattern to a second pest control device, wherein the second pest control device is configured to recognise the pest based on the received individual-specific sound pattern.

 According to a third aspect there is provided a method for recognizing pest by running the pest control system according to the second aspect to recognize a pest, the method comprising: recording one or more sound patterns, by the sound recording device; performing, by the processor, a recognition process identifying a pest species or a subgroup thereof based on the recorded one or more sound patterns by a comparison with a selection of sound patterns in the memory or a remote memory, wherein each sound pattern corresponds to the pest species or the subgroup thereof.

 In line with the features and advantages presented above with respect to the first and the second aspects, is that a method for recognizing pest species or a subgroup thereof is provided. With this third aspect of the invention, similar advantages and preferred features are present when applicable as in the previously discussed first and second aspects of the invention.

 According to some embodiments, the method may further comprise: transmitting to a second pest control device the one or more recorded sound patterns and data pertaining to the recognized pest species or a subgroup thereof.

An advantage being that an improved recognition of the pest at the second pest control device may thereby be achieved.

According to some embodiments, the method may further comprise: initiating tracking of a pest by identifying an individual-specific sound pattern for the pest; and
5 sending the individual-specific sound pattern to another pest control device.

Effects and features of the second and third aspects are to a large extent analogous to those described above in connection with the first aspect. Embodiments mentioned in relation to the first aspect are largely compatible with the second and third aspects.

10 The present disclosure will become apparent from the detailed description given below. The detailed description and specific examples disclose preferred embodiments of the disclosure by way of illustration only. Those skilled in the art understand from guidance in the detailed description that changes and modifications may be made within the scope of the disclosure.

15 Hence, it is to be understood that the herein disclosed disclosure is not limited to the particular component parts of the device described or steps of the methods described since such device and method may vary. It is also to be understood that the terminology used herein is for purpose of describing particular embodiments only, and is not intended to be limiting. It should be noted that, as used in the specification and
20 the appended claim, the articles "a", "an", "the", and "said" are intended to mean that there are one or more of the elements unless the context explicitly dictates otherwise. Thus, for example, reference to "a unit" or "the unit" may include several devices, and the like. Furthermore, the words "comprising", "including", "containing" and similar wordings does not exclude other elements or steps.

25

Brief descriptions of the drawings

The above objects, as well as additional objects, features and advantages of the present disclosure, will be more fully appreciated by reference to the following illustrative and non-limiting detailed description of example embodiments of the
30 present disclosure, when taken in conjunction with the accompanying drawings.

Figure 1 shows schematically a pest control device for recognizing pest according to some embodiments of the present disclosure.

Figure 2 shows schematically a pest control device for recognizing pest according to some embodiments of the present disclosure.

5 Figure 3 shows schematically a pest control device for recognizing pest according to some embodiments of the present disclosure.

Figures 4a and 4b show schematically a pest control device for recognizing pest according to some embodiments of the present disclosure.

10 Figure 5 shows by way of example an apartment comprising a number of pest control devices.

Figure 6 shows schematically a pest control device for recognizing pest according to some embodiments of the present disclosure.

Figure 7 shows schematically a pest control system for recognizing pest according to some embodiments of the present disclosure.

15 Figure 8 shows schematically a pest control device for recognizing pest according to some embodiments of the present disclosure.

Figure 9 shows schematically a flowchart for a method for recognizing pest by running a pest control system.

20 Detailed description

The present disclosure will now be described with reference to the accompanying drawings, in which preferred example embodiments of the disclosure are shown. The disclosure may, however, be embodied in other forms and should not be construed as limited to the herein disclosed embodiments. The disclosed
25 embodiments are provided to fully convey the scope of the disclosure to the skilled person.

Figure 1 shows schematically a pest control device 10 for recognizing pest according to some embodiments of the present disclosure. The pest control device 10 and examples of pests 11 are illustrated in Figure 1. The pest control device 10

comprises: a housing 12; a processor 14; a memory 16; and a data communication device 18. The data communication device 18 may be configured to communicate with another pest control device. The data communication device 18 may also be configured to communicate with a gateway 20. The pest control device 10 further
5 comprises a sound recording device 24 configured to record one or more sound patterns.

The sound recording device 24 may in some embodiments be referred to as a microphone.

The processor 14 may be configured to perform a recognition process
10 identifying a pest species or a sub-group thereof based on the recorded one or more sound patterns by a comparison with a selection of sound patterns in the memory 16 or in a remote memory 17, wherein each sound pattern corresponds to the pest species or the subgroup thereof.

The comparison may be to match the recorded sound pattern with a stored
15 sound pattern in the memory 16 or the remote memory 17. The remote memory 17 may be accessible via the gateway 20. The stored sound pattern may form part of a database in a memory 16, 17. The comparison may comprise artificial intelligence, AI, algorithms to identify one or more sound patterns based on training data comprising recorded sound patterns from pests matched with data pertaining to which pest
20 species that is generating the sound patterns.

The wording "pest" may be understood refer to one or more individuals of an insect or mammal species considered destructive. The sound pattern may form part of a sound generated by individuals of the pest species, the subgroup or a specific individual of the pest species.

25 The sound recording device may be arranged to detect sound generated by one or more pest species, 19a, 19b, 19c as exemplified in Figure 1.

The pest species 19a, 19b, 19c can be an insect species 19a, 19b. Here illustrated by a bed bug 19a, and a cockroach 19b. The insects may be of different species according to other embodiments, such as mosquitos, flies or grasshoppers.

30 The pest species 19a, 19b, 19c may be a mammal 19c, here exemplified by a rat 19c. The wording mammal species should be construed broadly and may comprise

rodents, such as mice, rats and other gnawing mammals. The sound recording device 24 may be arranged to detect sound in the audio frequency range. The audio frequency range may be from about 20 Hz to 20 000 Hz. The audio frequency range may be understood as the corresponding to the audible sound for humans. The sound recording device 24 may also or alternatively, be arranged to detect sound in the ultrasonic sound range. The ultrasonic sound range may be understood as comprising sound waves having a frequency above 20 000 Hz. The sound recording device may be arranged to also or alternatively detect sound waves having a frequency below the frequency of 20 Hz. Sound having sound waves with frequency below 20 Hz may be referred to as the infrasonic sound range.

The pest control device may in some examples comprise a plurality of sound recording devices. The plurality of sound recording devices may be configured to detect sound in the same frequency range. The plurality of sound recording devices may alternatively be configured to detect sound in different frequency ranges.

By way of example, insects may communicate by stridulation. Stridulation may produce sound by frictional mechanism such as movement of two body parts against each other in order to emit a sound. The sound generated may be characteristic for a specific pest species. The pest control device 10 may therefore be configured to identify the pest species by a sound pattern pertaining to the stridulation sound. By way of example, grasshoppers may emit a stridulation sound in the range of 5 000 Hz to 6 000 Hz.

By way of another example, pest engaging in social groups may use acoustic signals, to communicate and play with as well as to alarm or attract other individuals of the species. Rats, for example, may communicate at a frequency of about 50 000 Hz.

By way of yet another example, adult mice may emit ultrasonic vocalizations having frequencies in the range of 30 000 Hz to 100 000 Hz.

The pest control device 10 may be configured to save the recording of the one or more sound patterns and data pertaining to the identified pest species to the memory 16 of the pest control device 10. A database comprising a plurality of sound recordings may thereby be built up. The plurality of sound recordings may be understood as a library of sound patterns each sound pattern pertaining to sound generated by individuals of a pest species, a subgroup or a specific individual of the

pest species. A more precise recognition of a pest species may thereby be achieved. By way of example, subgroups of a species such as males, females, adults, infants may generate different sounds. The pest control device 10 may thereby be configured to recognize a subgroup of a pest species based on the one or more recorded sound patterns pertaining to sounds generated by that sub-group of the pest.

To this end, sound patterns generated by a pest species moving around and/or within the pest control device. By way of example, the sound of a cockroach moving within the pest control may generate a sound pattern as the legs of the cockroach comes in contact with a surface of the pest control device.

The pest control device 10 may be configured to, by the data communication device 18, transmit data pertaining to the recording of one or more sound patterns and/or the identified pest species or a subgroup thereof to another pest control device 10 and/or to the gateway 20.

The pest control device 10 may comprise a sound emitting device 22. The sound emitting device 22 may be configured, by the processor 14, to emit a sound selected to attract a pest species or a subgroup thereof. The memory 16 may comprise the sound for attracting the pest species or a subgroup thereof. The sound emitting device 22 may be arranged, by the processor 14, to replay a sound pattern recorded by the sound recording device 24. Local variations in the sound pattern pertaining to a specific subgroup of a species may thereby be utilized. Sound generated by the attracted pest may thereby be recorded in order to collect a larger number of sound patterns in the memory 16, 17.

The sound emitting device may in some embodiments be referred to as a loudspeaker.

With reference to Figure 2, the pest control device 10 may comprise a camera 26 arranged to record imaged data of the pest 11. The image data of the pest 11 may be stored on the memory 16. The identification made in the recognition process may further be based on a combination comprising the image data and the recorded one or more sound patterns. Put differently, the recognition process may be based on a combination of one or more sound patterns and image data. An improved identification of the pest may thereby be obtained. By way of example, the image data may be used to determine a subgroup of a pest species 11, as identified by the rat 19c. The

subgroup of the pest species 11 is here exemplified by a characteristic pattern 27. This or other characteristics may be used in the recognition process. As an example, female rats may be smaller, more streamline and narrow compared to male rats and the two genders may be recognized from the image data. A more precise recognition of a pest species of subgroups thereof may thereby be achieved. To this end, the image data may be used to associate a sound pattern with a species or a subgroup thereof. A more reliable database of sound patterns, each correlated with a pest species or a subgroup thereof may be generated. A sound pattern from a specific individual of a pest species may further be determined and stored. An improved recognition process for identifying a pest species or a subgroup thereof may be obtained.

With reference to Figure 3, the pest control device 10 may comprise a passive sensor 28 arranged to detect sensor data pertaining to the presence of a pest 11. The sensor data of the pest 11 may be stored on the memory 16.

The passive sensor 28 may be a passive infra-red, PIR, sensor according to some examples. The passive sensor 28 may be used to wake up the pest control device 10 from an idle state to an active state. The pest control device 10 may be configured to in the idle state reduce energy consumption for an energy source of the pest control device 10 such as a battery for powering the pest control device. The pest control device 10 may be configured to in the active state activate the processor 14 and/or the sound recording device 24 such that one or more sound patterns may be recorded. The pest control device 10 may further comprise a heat plate 29 arranged such that a temperature difference between the heat plate and the pest 11, 19b may be detected by the passive sensor 28. A presence of pest may thereby be detected.

The passive sensor may also be a temperature sensor, a weight sensor or a gas sensor configured to determine the presence of the pest.

The pest control device 10 may be a monitoring device 32 for monitoring mammals or insect pest, see Figure 1. The pest control device may be a trap device 34 for mammal or insect pest. According to other embodiments the pest control device may be both a trap and a monitoring device 32, 34, as will be discussed.

With reference to Figures 4a and 4b a pest control device 10 is exemplified. The pest control device 10 is arranged as a combined trap and a monitoring device 32, 34.

By way of example, the pest control device 10 is configured to monitor and trap pests 11, e.g. a mammal species, such as rats 19c. The pest control device 10 may in other examples be arranged to monitor or trap mice, ferrets, minks, moles or other rodents. The pest control device 10 may be arranged to attract pest by emitting sound by a
5 sound emitting device 22 as discussed above. The pest control device 10 may be arranged to record a sound generated by the attracted pest 11, 19c by use of the sound recording device 24.

According to some examples, as illustrated in Figures 4a and 4b, the pest control device 10 may have the housing 12 in the form of a box arrangement into
10 which the pest 11 may be lured. The box arrangement may have a predetermined size chosen to be suitable for a particular animal. The box arrangement may further have a cover and/or the entrance opening suitable for a certain type of animal. The box arrangement may form a resonance chamber.

The shape and/or size of the resonance chamber may be set to determine at
15 which frequencies the chamber should resonate. The resonance chamber may for example have a cylindrical, a spherical, or a rectangular shape. The dimensions of the resonance chamber may be chosen to match the wavelength of a desired resonant frequency. In other words, the shape of the box arrangement may have dimensions chosen to be suitable for amplifying the sounds generated by a particular animal, e.g. a
20 rodent. The amplification of a sound may pertain to an amplification of wavelengths of a desired frequency range. An advantage being that the resonance chamber provides a sound amplification and/or acoustic enhancement of sounds generated by a particular pest.

The housing may be arranged to enclose the sound recording device. The
25 housing may comprise an opening. The opening may be arranged to allow for a pest to enter the housing.

The housing may comprise an inner partition wall arranged at a distance from and partly covering the opening. Undesired sounds transfer between the inner space of the housing and the surroundings may thereby be reduced. Put differently, the
30 housing may comprise one or more wrapped walls preventing direct sound transmission through the opening.

The housing may be arranged to provide external protection to the sound recording device. The housing may be arranged to reduce undesirable acoustical reflections from internal surfaces of the housing. A confined space with well-defined geometry may thereby be achieved resulting in predictable sound reflection properties.

- 5 The housing may comprise acoustic isolation. The acoustic isolation may be arranged to block sound entering into the housing from outside.

By way of example the housing may comprise a curved surface partly encircling the sound recording device. An advantage is that the amount of sound reflected within the housing reaching the sides and rear of the microphone may be reduced. Put
10 differently, reverb may be reduced.

The curved surface may be a sound reflexion filter. The quality of the recording of one or more sound patterns from a pest located in front of the sound recording device and the sound reflexion filter may thereby be reduced.

- 15 A reflection filter may be understood as a structure arranged to reduce the amount of room ambience and unwanted noise within the housing that may be picked up by the sound recording device during a recording.

The housing may comprise a sound absorbing panel. The sound absorbing panel may be arranged on or form a surface opposite to the sound recording device. The quality of the recording of one or more sound patterns from a pest located
20 between the sound recording device and the sound absorbing panel may thereby be reduced.

The sound recording device may be directional. Selective recording of a pest may thereby be achieved.

- 25 The sound recording device may be arranged at a same position for each of a plurality of pest control devices. An improved comparison between the recorded one or more sound patterns between different pest control devices may thereby be achieved.

The animal may be a mammal or an insect.

As exemplified in Figures 4a and 4b, the pest 11, 19c may be present inside the box arrangement and the pest control device 10 may signal, via wireless data

communication using the data communication device 18 that the pest 11 is present and/or recognized.

The pest control device 10 may further be arranged to be in a loaded state 35 or an unloaded state 37. The pest control device 10 may further comprises a state sensor
5 for determining the state of pest control device 10, i.e. if the trap device 32 is in a loaded or unloaded state 35, 37. In more detail, the unloaded state 37 may be understood as a state where the trap device 32 is triggered in response to the presence of the animal. The processor 14 and the sound recording device 24 may be configured to determine if the pest 11 is trapped or not. By way of example, the
10 trapping of the pest 11, 19c may be determined by recording a sound pattern generated by the pest. The sound recording device 24 may act as a state sensor. According to some examples, the sound generated by the pest 11, 19c may be indicative of distress and/or be a warning call. The processor 14 may be configured to in the recognition process identify a state of a pest by a recorded sound pattern.

15 With further reference to Figures 4a and 4b, it is exemplified that the pest control device 10, may further comprise a vibration sensor 33 arranged to vibrate in response to pest 11, 19c moving across a surface of the housing 12.

The pest control device 10 may further be configured to detect, by the vibration sensor 33, a vibrational pattern generated by the pest 11, 19c. The vibration pattern
20 may be understood as comprising data pertaining to the vibrations generated as the pest move on the surface of the vibration sensor 33. By way of example, the vibration pattern may be a generated by the stride of a pest walking or moving on the vibration sensor 33. The recognition process of the pest control device may further be based on the vibrational pattern. Put differently, the recognition process may be based on the
25 recorded one or more sound patterns and the vibrational pattern.

The vibration sensor may be an accelerometer for measuring vibration and/or acceleration of motion. The vibration sensor may comprise a transducer configured to convert mechanical force exerted on the vibration sensor into an electrical signal. The vibration sensor may be a piezoelectric vibration sensor.

30 The vibration sensor may comprise a strain gauge. The strain gauge may be configured such that a resistance of the strain gauge varies with applied force. Put differently, the strain gauge is configured to converts a force and/or pressure, exerted on the vibration sensor into a change in electrical resistance.

The vibration sensor may be a capacitive displacement sensor. The vibration sensor may be a non-contact device configured to measure the position and/or change of position of a conductive component. The vibration sensor may thereby be configured to operate with magnetic fields.

- 5 Put differently, the vibration sensor may measure the interaction of magnetic fields. As the field interaction changes the sensor will produce a voltage proportional to the change in the interaction of the two fields.

The vibration sensor may be a triboelectric vibration sensor. The vibration measurement may be achieved by measuring vibration displacement and/or vibration
10 acceleration.

The vibration sensor may measure vibration amplitude, frequency, and/or phase.

The vibration sensor may be configured for energy harvesting. Put differently, forces exerted on the vibration sensor may be used to generate energy. The energy
15 generated may be used to operate the pest control device. By way of example, the pest control device may comprise a battery. The energy generated by the vibration sensor may be used to charge the battery. The energy generated may be used may to power the data communication device. A more energy efficient pest control device may thereby be achieved.

20 The memory 16 and/or the remote memory may comprise with a selection of vibration patterns, each vibration pattern corresponding to a pest species or a subgroup thereof.

According to some embodiments the vibration sensor 33 may further be arranged to determine a moving direction of the pest moving across the surface of the
25 vibration sensor 33. The vibration sensor 33 may be used to determine the state of the pest. By way of example, an injured pest may have a different vibrational pattern than a non-injured pest. To this end, different subgroups of a pest may generate different vibration patterns. By way of example, an infant pest may generate a different vibration pattern than an adult pest. The vibration pattern may comprise a characteristic of a
30 vibration. The vibration pattern may, by way of example, comprise spectral components of the vibration. The vibration pattern may be a vibration spectrum. The vibration pattern may comprise a single sound attribute or a plurality of vibration

attributes. The vibration attributes may comprise at least one of a frequency, amplitude, and vibration spectrum.

According to some examples, the vibration sensor 33 may be configured to detect a vibrational pattern generated by insects being stationary or moving on the vibration sensor. The beating of wings may by way of example cause vibrations that may be detected by the vibration sensor 33.

According to some examples the vibration sensor may be arranged inside or on an outer surface of the housing and configured to detect vibrational pattern transmitted by a surface and/or wall of the housing to the vibration sensor.

According to some examples the recognition process may be based on the recorded at least one vibration pattern is further based on additional sensor data regarding humidity, temperature, and/or presence of humans. Variations in the environment may thereby be compensated for in the recognition process.

According to some example, the pest control device 10 may be arranged to record and establish a base level vibration of the surrounding and deducting the base level vibration from the recorded vibration pattern used for recognizing a vibration pattern.

Figure 5 illustrates, by way of example, an apartment 40 comprising a number of pest control devices 10, 30. The apartment 40 has a kitchen area 42 and a living area 44. The pest control devices 11, 30 are configured to detect the pest species and/or the subgroup thereof, here exemplified by the pest 11 in the form of the rat 19c. With reference to Figure 5, the pest control device 10 may according to some embodiments be configured to initiate tracking of the pest 11 by identifying an individual-specific sound pattern, or species-specific sound pattern, for the pest 11, 19c and send the individual-specific sound pattern to another pest control device 30, as illustrated by the dashed lines 46. As an example, the pest 11, 19c may be tracked as the pest 11, 19c moves from the kitchen area 42 to the living area 44.

To this end, a first pest control device 10 may be configured to transmit to a second pest control device 30 the one or more recorded sound patterns and data pertaining to the recognized pest species or a subgroup thereof.

According to some examples, the memory of the pest control device may comprise location data pertaining to the location of that pest control device. The location data may comprise coordinates according to a Global Positioning System, GPS.

- 5 The pest control may be configured to transmit location data to another pest control device. The distance between two or more pest control devices may thereby be determined.

- According to some examples the distance between two pest control devices may be known. The speed at which a pest moves from the first pest control device to
10 the second pest control device may thereby be determined.

 The pest control device may be configured to perform time resolved detection of a sound pattern. The point in time at which the sound pattern was detected may thereby be determined.

- The pest control device may be configured to transmit data pertaining to the
15 determined point in time to another pest control device.

 The one of more pest control devices may be time synchronized.

- The plurality of pest control devices 10, 30 may form part of a pest control system 36. The system may thereby allow for tracking of a pest 11, 19c such that a route for the pest 11, 19c may be determined. Put differently, the pest control system
20 36 may be configured to track the pest 11 by recognizing the individual-specific sound pattern at a first pest control device 10 and send the individual-specific sound pattern to another pest control device 30. Pathways for individual pests may thereby be determined. By way of example, the trap device 32 may be position adjacent to the determined route, as exemplified by the pest control device 30 placed in the living area
25 44. The pest control device 30 may be the monitoring and trap device 32, 34. Efficient pest control may thereby be provided. According to some examples the monitoring and trap device 32,34 may comprise the sound emitting device 22 for attracting the pest 11, 19c.

- According to other examples, subgroups of a pest species may be tracked by
30 the plurality of pest control devices 10, 30.

According to some examples, the pest control device 10 may comprise a resonating chamber within the housing for amplifying a species-specific sound frequency range.

Figure 6 illustrates such a pest control device 10 comprising two resonating chambers 31a, 31b. The resonating chambers 31a, 31b are formed within the housing 12 and is arranged to amplify sound generated by a pest located within the resonating chamber 31a, 31b. Put differently, the resonating chambers are arranged to amplify sound within a sound frequency range.

According to other examples, the pest control device may comprise a plurality of resonance chambers. The plurality of resonance chambers may be arranged to amplify the same frequency ranges. The plurality of resonance chambers may alternatively be arranged to amplify different frequency ranges. The different sound frequency ranges may be species-specific. Different resonance chambers may have different dimensions.

To this end, a resonance chamber may have different dimensions in different directions. Put differently, the dimensions of the resonance chamber may differ in different directions. By way of example, a rectangular resonance chamber having unequal sides may amplify a plurality of frequencies or frequency ranges. The resonant frequencies of such a chamber are determined by its dimensions along each axis, e.g. length, width, and/or height. An advantage may be that enhanced acoustic properties of the resonance chamber are provided leading to better sound quality. An improved recognizing of a pest may be achieved. An improved identifying a pest species or a subgroup thereof may be achieved.

The wording “resonance chamber” may be understood as an enclosed space that has at least one opening through which a sound wave may enter and exit after that the sound wave has bounced back and forth between the internal walls of the chamber such that a resonance phenomenon occurs. Alternatively, or in combination the sound waves may be generated within the resonance chamber. As more sound waves enter or are generated within the resonance chamber, the sound waves may be combined with and reinforce one or more standing waves within the resonance chamber thereby increasing the intensity of the sound. In other words, the resonance chamber may be understood as a structure or space designed to amplify sound waves by resonating at specific frequencies. The amplification of sound waves occurs when

the sound waves reflect off two or more walls of the resonance chamber and interfere constructively with each other.

The resonance chamber, may according to some examples be understood as a resonating chamber or a resonance cavity.

5 The dimensions of the resonance chamber may be set to amplify a sound generated by a specific pest species. By amplifying sounds generated by a pest an improved quality of the recording of the one or more sound patterns may be achieved.

 According to some embodiments the two chambers 31a, 31b may have different dimensions, as illustrated in Figure 6. The two chambers 31a, 31b may thereby be
10 arranged to amplify different sound frequency ranges. The different sound frequency ranges are here exemplified as species-specific. By way of example, the chamber 31a may be arranged to amplify sound generated by a first pest species 11, 19b and the chamber 31b may be arranged to amplify sound generated by a second pest species 11, 19a. The sensitivity for the pest control device 10 may thereby be increased.

15 According to some examples, the pest control device 10 may comprise: at least one additional sound recording device 25; wherein the processor 14 in combination with the memory 16 is arranged to receive signals from the multiple sound recording devices 24, to link the signals to detection time points and to process the signals and the detection time points into sensor data sets; and wherein the pest control device 10
20 is configured to track pest within the pest control device 10 by time resolved detection of a sound pattern from the multiple sound recording devices.

 According to some examples, the at least two of the plurality of sound recording devices are arranged at a known distance from each other. The speed at which the pest moves may thereby be determined.

25 According to some examples, the memory of the pest control device may comprise distance data pertaining to the distance between the one or more sound recording devices of the pest control device.

 According to some examples, the pest control device may comprise multiple sound recording devices 24, 25, each device being arranged to detect a specific sound
30 frequency range different to the other sound recording devices.

According to some examples, the pest control device 10 may be arranged to record and establish a base level sound of the surrounding and deducting the base level sound from the recorded sound pattern used for recognizing a sound pattern.

Figure 7 shows the pest control system 36 according to some examples. The pest control system 36 may comprise multiple pest control devices 10 configured in a mesh network 38. The pest control device 10 may be the pest control device as described above. The pest control system 36 may comprise, by way of example, the gateway 20 configured for communication with the communication device 18 of one or more pest control devices 10. The gateway 20 and the pest control devices 10 may communicate with each other via wireless data communication. The gateway 20 and the pest control devices 10 may form a wireless data communication network 36. The wireless data communication network 36 may be structured into sub-networks. The sub-network may comprise one or more the pest control devices 10. The sub-network is configured to communicate with the gateway.

The wording gateway may be understood as device that connects networks together. The networks may have different transmission protocols. Put differently, the gateway 20 may be an entry point and exit point for data communication between different networks. By way of example, data communicated via wireless data communication between a pest control device 10 and the gateway 20 may be routed by the gateway 20 to a remote server 50 or the mobile device 52 via the mobile network 51. The network 38 may comprise a local server. The gateway 20 may further route data between two sub-networks or trees of pest control devices 10, where the pest control device of the sub-network or of the tree communicate via wireless data communication with other pest control devices in the same sub-network or tree of pest control devices. The pest control devices 10 may be monitoring devices 32 and/or trapping devices 34. According to some examples, the remote server 50 may comprise the remote memory 17. The remote memory 17 may comprise a database 23.

Figure 8 illustrates a pest control device 10 according to some examples, the pest control device further comprising at least one additional sound recording device 25. The processor 14 may be further configured to in combination with the memory 16 receive signals from the multiple sound recording devices 24, 25, to link the signals to detection time points and to process the signals and the detection time points into sensor data sets. The pest control device 10 is configured to track pest within the pest

control device 10 by time resolved detection of a sound pattern from the multiple sound recording devices. By way of example, a pest 11, 19c, may be tracked within the pest control device 10. The location and/or movement pattern of the pest within the pest control may thereby be determined.

5 The wording “multiple sound recording devices” is here to be understood as comprising a sound recording device plus at least one additional sound recording device.

 With reference to Figure 9 and Figure 1, a method for recognizing pest by running the pest control system 36 is illustrated. The method 80 comprising: recording
10 82 one or more sound patterns by the sound recording device 24; performing 84, by the processor 14, a recognition process identifying the pest species or the subgroup thereof based on the recorded one or more sound patterns by the comparison with the selection of sound patterns in the memory 16 or the remote memory 17, wherein each sound pattern corresponds to the pest species or the subgroup thereof.

15 The method 80 may further comprise: transmitting 86 to a second pest control device 30 the one or more recorded sound patterns and data pertaining to the recognized pest species or a subgroup thereof, as further illustrated in Figure 5.

 The method 80 may further comprise: initiating 88 tracking of a pest 11 by identifying an individual-specific sound pattern for the pest 11; and sending 90 the
20 individual-specific sound pattern to another pest control device 30.

 The method may further comprise: initiating tracking of a pest species by identifying a species-specific sound pattern for the pest; and sending the species - specific sound pattern to another pest control device.

 According to some examples, one or more sound patterns may be stored on the
25 memory of the pest control device.

 According to some examples, the method may comprise a calibration phase, wherein one or more sound patterns are recorded and matched with a pest species of a subgroup thereof such that a register or database is built up. The register or database may be transmitted from one pest control device to another pest control
30 device.

According to some examples, data pertaining to the identified pest species at a first pest control device may be transmitted to a second pest control device and wherein the recognition process identifying the pest species or the subgroup thereof at the second pest control device is based on the data pertaining to the identified pest
5 received by the second pest control device.

According to some examples, the sound recording device of a second pest control device may be configured to detect sound within a specific frequency range based on the identified pest received by from the first pest control device.

The person skilled in the art realizes that the present disclosure is not limited to
10 the preferred embodiments described above. The person skilled in the art further realizes that modifications and variations are possible within the scope of the appended claims. Additionally, variations to the disclosed embodiments can be understood and effected by the skilled person in practicing the claimed disclosure, from a study of the drawings, the disclosure, and the appended claims.

CLAIMS

1. A pest control device (10) for recognizing pest (11), comprising:
 - a housing (12);
 - a processor (14);
 - 5 a memory (16);
 - a data communication device (18) configured to communicate with a gateway (20) or another pest control device (10);
 - a sound recording device (24) configured to record one or more sound patterns; wherein the processor (14) is configured to perform a recognition process identifying a pest species or a subgroup thereof based on the recorded one or more sound patterns
 - 10 by a comparison with a selection of sound patterns in the memory (16) or in a remote memory (17), wherein each sound pattern corresponds to the pest species or the subgroup thereof.
2. The pest control device according to claim 1, wherein the pest control device
- 15 (10) is configured to save the recording of the one or more sound patterns and data pertaining to the identified pest species or subgroup thereof to the memory (16) of the pest control device (10).
3. The pest control device according to claim 1 or 2, wherein the pest control device (10) is configured to, by the data communication device (18), transmit data
- 20 pertaining to the recording of one or more sound patterns and/or the identified pest species or a subgroup thereof to another pest control device (10) and/or to the gateway (20).
4. The pest control device according to any one of the preceding claims, further comprising a camera (26) arranged to record image data of the pest (11); wherein the
- 25 image data of the pest (11) is stored on the memory (16); and wherein the identification made in the recognition process is further based on a combination comprising the image data and the recorded one or more sound patterns.
5. The pest control device according to any one of the preceding claims, wherein the pest control device (10) is configured to initiate tracking of a pest (11) by

identifying an individual-specific sound pattern for the pest (11) and send the individual-specific sound pattern to another pest control device (30).

6. The pest control device according to any one of the preceding claims, further comprising a resonating chamber (31a, 31b) within the housing (12) for amplifying a
5 species-specific sound frequency range.

7. The pest control device according to any one of the preceding claims, further comprising: at least one additional sound recording device (25);

wherein the processor (14) in combination with the memory (16) is configured to receive signals from the multiple sound recording devices (24, 25), to link the signals to
10 detection time points and to process the signals and the detection time points into sensor data sets; and

wherein the pest control device (10) is configured to track pest within the pest control device (10) by time resolved detection of a sound pattern from the multiple sound recording devices.

15 8. The pest control device according to any one of the preceding claims, wherein the housing (12) further comprises a vibration sensor (33) arranged to vibrate in response to the pest (11) moving across a surface of the housing (12); and detecting, by the vibration sensor (33), a vibrational pattern; wherein the recognition process is further based on the vibrational pattern.

20 9. The pest control device according to any one of the preceding claims, wherein the pest control device (10) is a monitoring device (32) arranged to allow the pest (11) to pass or a trapping device (34) arranged to capture the pest (11).

10. The pest control device according to any one of the preceding claims, wherein the pest species (19a, 19b, 19c) is an insect species (19a, 19b).

25 11. The pest control device according to any one of the preceding claims, wherein the pest species (19a, 19b, 19c) is a mammal species (19c).

12. A pest control system (36) comprising: multiple pest control devices (10) according to any one of the preceding claims configured in a mesh network (38).

13. The pest control system (36) according to claim 12, wherein a first pest
30 control device (10) is configured to transmit to a second pest control device (30) the

one or more recorded sound patterns and data pertaining to the recognized pest species or a subgroup thereof.

14. A method (80) for recognizing pest by running the pest control system according to any one of claims 12-13 to recognize a pest, the method (80) comprising:
5 recording (82) one or more sound patterns by the sound recording device (24);
performing (84), by the processor (14), a recognition process identifying a pest species or a subgroup thereof based on the recorded one or more sound patterns by a comparison with a selection of sound patterns in the memory (16) or a remote memory (17), wherein each sound pattern corresponds to the pest species or the subgroup
10 thereof.

15. The method for recognizing pest according to claim 14, the method (80) further comprising: transmitting (86) to a second pest control device (30) the one or more recorded sound patterns and data pertaining to the recognized pest species or a subgroup thereof.