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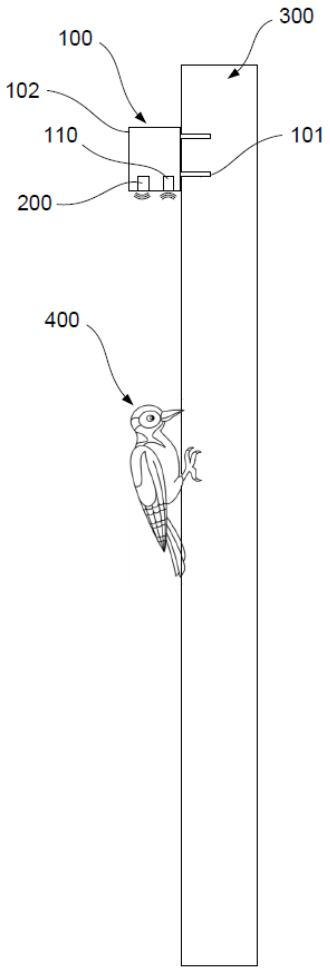
(54)	Title	**Apparatus and method for acoustic deterrent targeting individual species of woodpeckers.**
(56)	References Cited:	US 6396402 B1, WO 2005024782 A1, CN 113129907 A, CN 110716179 A
(57)	Abstract	

Apparatus (100) and method for acoustic deterrent targeting individual species of woodpeckers (400) pecking on a structure (300) or associated parts, wherein the apparatus (100) and method are configured to determine the woodpecker species and the type of activity of the involved woodpecker (400), and tailor a targeted response based on the determined species and activity to deter the pecking woodpecker (400).



Apparatus and method for acoustic deterrent targeting individual species of woodpeckers

The present invention is related to an apparatus and method for acoustic deterrent targeting individual species of woodpeckers, according to the preambles of claim 1 and 8, respectively.

Background

Woodpeckers can cause significant damage to buildings and other structures, as well as generate noise which can be disruptive to humans. Woodpeckers use their beaks to peck at surfaces creating holes used for nest-building, food-storage, “tools” to hold pinecones as well as finding food present inside. This behavior is defined as “work pecking” and differs from the pecking defined as “drumming” who is a way of signaling to other birds.

The “drumming” is characterized by a series of pecks that is used to signalize its appearance with a unique acoustic signature for each species of woodpecker. This pecking does in general not harm the material due to the rapid speed and less force involved.

The “work pecking” is characterized by the activity when the woodpecker uses its beak with a stronger force to make holes in the material, and so creates damages.

Accordingly, the pecking made by a woodpecker represents different activities that is essential to know before considering the deterring of the woodpecker.

Over the years, a number of electronic solutions have been presented to detect the presence of woodpeckers with the aim of deterring them. A common drawback with the systems is that they do not differ between its simple appearance and/or the eventual types of pecking activity that is taking place.

Further, the prior art systems fail to provide an identification of the exact woodpecker species involved and is thus not able to respond appropriately or designed relevant to the natural behavior of the relevant woodpecker species.

The prior art systems use different synthetic sounds, like ultrasound, or light flashes intended to deter all woodpecker species, or birds in general. Further, such synthetic scares are known to be subject of adaptation from the birds/woodpeckers and this will potentially make the deterrent less effective over time.

Another concern is that this deterrent strategy in general is intended to deter all woodpeckers from the vicinity regardless of damage/noise potential, and may as well disturb other birds and humans in the process that may have a negative effect on nature conservation. Accordingly, the prior art solutions will negatively affect the environment of all humans and animals in vicinity of the system.

Further, a lack of targeted deterrent strategy may also lead to the use of more energy in an electronic system making the solution less efficient and useful in remote locations.

From CN103385237A is known an ultrasonic bird repeller. The ultrasonic bird repeller comprises a bird repeller and a housing, and an accumulator, a driving circuit, an ultrasonic generator, a light emitting flash device, a control unit and an induction device are arranged in the bird repeller housing. The ultrasonic bird repeller is designed to repell birds by using ultrasonic wave and red flash.

In US 6396402 B1 is described an apparatus for deterring woodpeckers from tapping on and excavating within a utility pole or the like, wherein the apparatus includes a housing having mounting flanges for direct attachment to the pole so as to receive vibrations therefrom. A transducer is attached to the mounting wall so as to convert the vibrations preferentially over airborne sounds into signals. A circuit compares the vibrations with a long-term average and emits an output in response to detection above a threshold, whereupon the outputs are counted and if the number within a predetermined time exceeds a preset minimum a sound transmitter is actuated for emitting a deterrent sound externally of the housing. A memory contains a plurality of separate audible deterrent sounds including some of the same species and some of predators, which act as a deterrent to the woodpeckers and these are selected sequentially and transmitted after a delay to avoid habituation.

From prior art one may also refer to US20050049877A1 wherein is described a method and apparatus for automatically identifying animal species from their vocalizations. However, the solution will not be suitable for use on a pecking woodpecker.

Accordingly, there is a need for an apparatus and method for acoustic deterrent targeting individual species of woodpeckers enabling an automated deterrent, or a deterrent strategy based on classifying the type of woodpecker species and woodpecker activity detected.

There is further a need for an apparatus and method for acoustic deterrent targeting individual species of woodpeckers able to improve, by the use of machine learning, determination of species of woodpeckers, activity type and the deterring itself.

Object

The main object of the present invention is to provide an apparatus and method for acoustic deterrent targeting individual species of woodpeckers partly or entirely solving the drawbacks of prior art solutions.

An object of the present invention is to provide an apparatus and method for acoustic deterrent targeting individual species of woodpeckers enabling individual deterring of an identified woodpecker species.

It is an object of the present invention to provide an apparatus and method for acoustic deterrent targeting individual species of woodpeckers enabling tailored deterring response to identified woodpecker species.

An object of the present invention is to provide an apparatus and method for acoustic deterrent targeting individual species of woodpeckers preventing woodpeckers from adapting to deterrent actions.

It is an object of the present invention to provide an apparatus and method for acoustic deterrent targeting individual species of woodpeckers that is self-learning and able to adapt and improve by machine learning features.

An object of the present invention is to provide an apparatus and method for acoustic deterrent targeting individual species of woodpeckers actively preventing damage /or noise or both from woodpeckers to avoid costs and nuisance for people that is efficient over long term.

It is an object of the present invention to provide an apparatus and method for acoustic deterrent targeting individual species of woodpeckers that does not unintentionally disrupt other parts or animals of the ecosystem or is a nuisance for people and wildlife.

Further objects of the present invention will appear from the following description, claims and attached drawings.

The invention

An apparatus for acoustic deterrent targeting individual species of woodpeckers according to the present invention is defined by the technical features of claim 1. Preferable features of the apparatus are described in the apparatus dependent claims.

A method for acoustic deterrent targeting individual species of woodpeckers according to the present invention is defined by the technical features of claim 8. Preferable features of the method are described in the method dependent claims.

The present invention is related to an apparatus and method for acoustic deterrent targeting individual species of woodpeckers.

The apparatus and method according to the present invention is arranged to or in the vicinity of a structure or associated parts that is to be monitored. Examples of structures are buildings, chimneys, poles, etc.

In accordance with the present invention, the apparatus and method make use of at least one acoustic sensor array to register acoustic signal data associated with the structure or associated parts being monitored.

According to the present invention, the registered acoustic signal data are processed and compared with patterns or signatures unique for species of woodpeckers to determine the woodpecker species involved.

The present invention further comprises comparing the registered signal data with patterns or signatures unique for types of activity to determine the activity type of the involved woodpecker.

Based on the determined woodpecker species and activity type, a suitable and tailored deterrent action is chosen, adapted the woodpecker species in question.

In accordance with a further embodiment of the present invention it comprises using machine learning to develop and improve the criteria of the determination of the woodpecker species or activity type and/or deterrent action.

In accordance with a further embodiment of the present invention it also includes using machine learning to measure the effect of the deterrent action.

By the present invention is accordingly provided an apparatus and method for acoustic deterrent targeting individual species of woodpeckers capable of real-time or near real-time monitoring and deterrent of woodpecker damage and noise.

By the apparatus and method according to the present invention it is possible to distinguish between different activity types of the woodpecker species, and thus respond accordingly.

The apparatus and method according to the present invention enables the use of tailored responses using natural sounds that is known to deter the specific species of woodpeckers from specific activities.

By the present invention it is enabled an automatic and remote solution requiring minimum of installation effort and maintenance.

Due to the possibility to tailor the deterrent action, the apparatus and method for acoustic deterrent targeting individual species of woodpeckers will provide a solution that does not unintentionally disrupt other parts or animals of the ecosystem or is a nuisance for people and wildlife.

The present invention provides a solution that is self-improving by measuring the results of the classifications model accuracy and the response from the deterrent strategy used.

Further preferable features and advantageous details will appear from the following example description, claims and attached drawings.

Example

The present invention will below be described in further detail with reference to the attached drawings, where

Fig. 1a-b are principle drawings of an apparatus for acoustic deterrent targeting individual woodpecker species according to an embodiment of the present invention, and

Fig. 2 is a flow diagram of a method for acoustic deterrent targeting individual woodpecker species according to the present invention.

Reference is now made to Figures 1a-b showing principle drawings of an apparatus 100 according to one embodiment of the present invention for acoustic deterrent targeting individual woodpecker species. In Fig. 1a is shown a principle drawing where an apparatus 100 according to the present invention is arranged on or near a structure 300 to be monitored by suitable attachment means 101, such as bolts or similar. In Fig. 1a is further shown a woodpecker 400 pecking on the structure 300.

In Fig. 1b is shown a block diagram of the apparatus 100 according to the present invention. The apparatus 100 according to the present invention comprises at least one sensor array 110 comprising at least one acoustic sensor 111 configured to register (measure) acoustic signal data of pecking from woodpeckers 400 on the structure 300 or associated parts. The apparatus 100 according to the present invention further comprises a control unit 120 configured, by comprising means and software, to process the registered acoustic signal data into datasets.

In accordance with the present invention, the apparatus 100 further comprises an internal or external memory 130, in the shown embodiment integrated in the control unit 120, which memory 130 is used for storing the registered acoustic signal data after processing by the control unit 120 as data sets in the internal or external memory 130.

The control unit 120 according to the present invention is configured, by comprising means and software, to determine the species of woodpeckers 400 involved based on comparing the registered acoustic signal data with patterns, signals or signatures unique for each woodpecker species stored in a database in the internal or external memory 130. In accordance with a preferred embodiment of the present invention, the present invention makes use of the pecking as it is registered in the monitored structure 300 or associated parts, and the database comprises patterns, signals or signatures of such pecking.

Other examples of patterns, signals or signatures that are used for determining the woodpecker species involved that may be used in addition or instead of the former are:

- sounds like churrs, purrs, rattles, chatters, screeches, and other short sounds, such as “peek” and “pik” notes, and/or

- tempo, rhythm, duration, and repetition of drumming patterns or signatures.

Other unique patterns, signals or signatures will be within the knowledge of a skilled person.

According to the present invention, the control unit 120 is further configured, by comprising means and software, to determine the type of activity of the involved woodpecker 400 based on comparing

the registered acoustic signal data with patterns or signatures unique for each type of activity stored in the same or different database in the internal or external memory 130. Drumming and work pecking are examples of two types of activities with different patterns, signatures, signals, etc. that one should distinguish between. Examples of patterns, signals or signature of woodpecker activity that are used for determining the activity according to the present invention, are tempo, rhythm, duration, and repetition of drumming patterns or signatures, as well as volume. Other unique patterns, signals or signatures will be within the knowledge of a skilled person.

The control unit 120 is further configured, by comprising means and software, to, based on the determined woodpecker 400 species and type of activity, chose a targeted deterrent action from available deterrent actions stored in the same or separate database in the internal or external memory 130.

The apparatus 100 according to the present invention further comprises at least one acoustic deterrent emitter 200 configured to emit chosen deterrent acoustic signals to deter the identified woodpecker 400 species.

In accordance one embodiment of the apparatus 100 according to the present invention, the control unit 120 is configured, by comprising means and software, to control settings of the at least one acoustic deterrent emitter 200 to emit a targeted deterrent signal according to the chosen targeted deterrent action to deter the identified woodpecker 400 species.

According to a further embodiment of the apparatus 100 according to the present invention, the acoustic sensors 111 of the at least one sensor array 110 are configured to register acoustic signals data of pecking that create vibrations propagating in the monitored structure 300 or associated parts.

In accordance with a further embodiment of the apparatus 100 according to the present invention the acoustic sensors 111, control unit 110 or both is configured, by comprising means and software, to filter out soundwaves via the surrounding air that may disturb the acoustic sensor 111 measurements or deteriorate determination of the woodpecker 400 species. In this manner one also provides a coarse filtering of the registered acoustic signal data, reducing the load of the control unit 120.

According to a further embodiment of the apparatus 100 according to the present invention, the apparatus 100 further is configured for machine learning. In accordance with one embodiment the apparatus 100 according to the present invention, it comprises a separate machine learning module

140, while in an alternative embodiment, the machine learning is integrated in the control unit 120. According to the present invention, the separate machine learning module 140 or control unit 120 is configured, by comprising means and software, to perform machine learning. In accordance with one embodiment of the present invention, the machine learning comprises classifying the datasets by assistive machine learning methods of the registered acoustic signal data from the at least one sensor array 110 to identify the type of activity performed by the woodpecker 400 and if it is causing damage to the structure 300 or associated parts, and/or noise.

In accordance with one embodiment of the apparatus 100 according to the present invention, the machine learning module 140 or control unit 120 with machine learning is configured to determine the type of pecking activity of the involved woodpecker 400 species based on stored patterns or signatures unique for each activity in the same or separate database in the internal or external memory 130.

According to a further embodiment of the apparatus 100 according to the present invention, the machine learning module 140 or control unit 120 with machine learning is configured to determine the woodpecker 400 species involved based on stored patterns or signatures unique for each woodpecker 400 species in the same or separate database in the memory 130.

In accordance with one embodiment of the apparatus 100 according to the present invention, the machine learning module 140 or control unit 120 with machine learning is configured to perform training using a set of historical acoustic signal data of woodpeckers 400 pecking and configured to adapt and update analysis and responses, i.e. targeted deterrent signal settings, based on new acoustic sensor signal data as it is received.

According to one embodiment of the apparatus 100 according to the present invention, the at least one acoustic deterrent emitter 200 is arranged on or near the monitored structure 300 and configured, by comprising at least one transducer 201 or loudspeaker, emitting a targeted deterrent signal in the form of natural sounds tailored to deter the identified woodpecker species from causing further activity.

According to a preferred embodiment of the present invention, the deterring sound(s) is/are of woodpeckers within the same or different species.

Other examples of deterring sounds that may be used in addition or instead of the former are sounds of natural enemies of the woodpeckers, such as cries of hawks, owls or eagles and other predators, other sounds that the woodpecker finds annoying, such as loud noises of banging pots

or pans, human voices yelling, bird distress calls, frequency or volume of the emitted sounds, etc. Other deterring sounds will be within the knowledge of a skilled person.

In accordance with a further embodiment of the apparatus 100 according to the present invention, the at least one acoustic deterrent emitter 200 is activated based on the output of the separate machine learning module 140 or control unit 120, and is configured to be adjusted or disabled as needed.

According to one embodiment of the apparatus 100 according to the present invention, the apparatus 100 is configured for real-time or near real-time monitoring and deterrent of woodpecker damage and noise.

In accordance with one embodiment of the apparatus 100 according to the present invention, the components of the apparatus 100 are joined in a housing 101 protecting the components, with associated slits or perforations for the at least one acoustic sensor array 110 and acoustic deterrent emitter 200. Alternatively, one or more of the components are arranged in separate housings, as well as the apparatus 100 may be provided or arranged to remote acoustic sensor arrays 110 and acoustic deterrent emitters 200. In addition, two or more apparatuses 100 arranged within a communication range may cooperate both for the registration, determination and deterring of the woodpeckers.

In a further embodiment of the apparatus 100 according to the present invention, the apparatus 100 further comprises a wireless communication unit 150 enabling communication with external units, such as tablets, computers, phones or sky-services, for reporting and/or providing a user interface for controlling the settings of the control unit 140, acoustic sensor array 110 and/or acoustic deterrent emitter 200. In addition, the apparatus 100 itself may be provided with a display for providing a user interface.

The apparatus 100 is further provided with an internal or external energy storage 160, such as one or more batteries, alternatively or in addition, connected to wired energy supply systems if present and accessible. In accordance with a further embodiment of the apparatus 100 according to the present invention, the apparatus 100 comprises energy harvesting means (not shown), such as solar panels, enabling charging of the energy storage 160.

Reference is now made to Fig. 2 showing a flow diagram of a method for acoustic deterrent targeting individual species of woodpeckers 400 according to the present invention, which different aspects of the apparatus 100 according to the present invention works.

The method according to the present invention comprises a step 500 comprising registering woodpecker 400 pecking on a structure 300 to be monitored or associated parts thereof, by the at least one acoustic sensor array 110. The registered acoustic signal data is processed either by processing capacity in the acoustic sensor array 110 or control unit 120, and datasets are stored in the memory 130.

In accordance with one embodiment of the method, step 500 further comprises registering acoustic signal data of pecking that create vibrations propagating in the monitored structure 300 or associated parts. Accordingly, this embodiment will not be directed to measurements into the air, but the pecking as registered in the structure 300 or associated parts.

In accordance with a further embodiment of the method, step 500 further comprises filtering out soundwaves via the surrounding air that may disturb the acoustic sensor 111 measurements or deteriorate determination of the woodpecker 400 species and/or activity.

The method further comprises a step 510 comprising determining the species of woodpeckers 400 involved and type of activity performed by the involved woodpecker 400, based on comparing the registered acoustic signal data with patterns or signatures unique for each woodpecker 400 species and activity types stored in at least one database in the memory 130. Accordingly, in this manner providing a real-time or near real-time classification of the woodpecker 400 involved, as well as the type of activity performed by the involved woodpecker 400.

The method according to the present invention further comprises a step 520 comprising, based on the determined woodpecker 400 species and type of activity, choosing a targeted deterrent action from available actions stored in the same or separate database in the internal or external memory 130. In addition, the step 510 comprises controlling settings of the at least one acoustic deterrent emitter 200 according to the chosen deterrent action to emit a targeted deterrent acoustic signal to deter the identified woodpecker 400 species.

According to a further embodiment of the present invention, the method comprises machine learning steps 600-630.

According to one embodiment of the method it is comprising a machine learning step 610 of classifying the datasets by assistive machine learning methods of the acoustic signal data from the at least one sensor array 110 to improve the identification of the labelling/classification of the type of activity performed by the woodpecker 400 and if it is causing damage to the structure 300 or

associated parts, and/or noise. The improvements in the labelling/classification is used for adapting the settings of the control unit 120, i.e. step 510 of the method above.

The machine learning step 610 comprises determining the type of pecking activity of the involved woodpecker 400 species as well as determining the woodpecker species 400 involved, based on stored patterns or signatures unique for each activity and each woodpecker 400 species in the same or separate database in the internal or external memory 130 together with machine learning rules.

According to one embodiment of the method it is comprising a machine learning step 620 of training using a set of historical acoustic signal data of woodpeckers 400 pecking and adapt and update analysis and responses based on new sensor data as it is received. Results of the training is used for adapting the settings of the control unit 120, i.e. step 510 of the method above.

In accordance with a further embodiment of the method according to the present invention, the method comprises a step of reporting to a user of incidents and actions taken.

According to one embodiment of method according to the invention, the method comprises transferring the datasets of acoustic signal data to a remote unit for performing machine learning on the remote unit. The remote unit is then transferring the results back to the apparatus 100 for implementation of settings.

The method according to a further embodiment of the present invention comprises a method step and/or machine learning step 630 of measuring the effect of deterrent response (activity) and using the collected data to improve classifications and response (activity) parameters (settings).

In accordance with a further embodiment of the present invention, two or more apparatuses 100 are arranged cooperating by means of the wireless communication units 150. In such an embodiment, the results of the machine learning can be distributed to the other apparatuses 100.

According to a further embodiment of the present invention, the apparatus 100 comprises one or remote acoustic deterrent emitters 200, provided with wireless communication units, controllable by the control unit 120 via the wireless communication unit 150.

In accordance with a further embodiment of the present invention, the apparatus 100 comprises one or remote acoustic sensor arrays 110, provided with wireless communication units, enabling extended registration of acoustic signal data of pecking from woodpeckers on the structure 300 or associated parts via the wireless communication unit 150.

The above described embodiment may be combined to form modified embodiments within the scope of the attached claims.

Accordingly, by the present invention is provided an apparatus 100 and method that enables real-time or near real-time monitoring and control of woodpecker damage and noise.

By the present invention is provided an apparatus and method enabling early detection and effective deterrent measures to be taken.

The present invention thus provides a solution capable of protecting structures 300 and associated parts from damage, reducing the risk of costly repairs or replacements and prevent the noise created from the pecking of woodpeckers.

By the present invention is enabled an automatic and remote solution, that is plain to install and of low costs.

The present invention further enables a solution enabling the identification of the woodpecker species, as well as being able to differ between the type of pecking activity, and using this information to tailor the response and thus enable a targeted response to deter the identified woodpecker species.

Further, due to the machine learning features, the present invention enables a solution that is able to self-improve by measuring the results of the classification model's accuracy and the response from the deterrent strategy used.

Modifications

In an alternative application area, which is not a part of the present invention, the present invention is used on other birds or animals to deter other unwanted behavior from animals or birds, if the activity has unique patterns or signatures that can be detected by the at last one sensor array and accompanied with a targeted deterrent response.

According to an alternative embodiment of the present invention, which is not a part of the present invention, other deterrent means, such as light, vibration, are used in combination with the at least one acoustic deterrent emitter.

Claims

1. Apparatus (100) for acoustic deterrent targeting individual species of woodpeckers (400) arranged on or near a structure (300) to be monitored, wherein the apparatus (100) comprises at least one sensor array (110) comprising a plurality of acoustic sensors (111), a control unit (120) and at least one acoustic deterrent emitter (200), wherein the sensor array (110) is configured to register acoustic signal data of pecking from woodpeckers on the structure (300) or associated parts,

wherein the apparatus (100) comprises a control unit (120) configured, by comprising means and software, to

- determine the species of woodpeckers (400) involved based on comparing the registered acoustic signal data with patterns or signatures unique for each woodpecker (400) species stored in a database in an internal or external memory (130) of the apparatus (100),

- determining the type of activity of the involved woodpecker (400) based on comparing the registered acoustic signal data with patterns or signatures unique for each type of activity stored in the same or different database in the internal or external memory (130) of the apparatus (100),

- based on the determined woodpecker (400) species and type of activity, chose a targeted deterrent action from available deterrent actions stored in the same or separate database in the internal or external memory (130) of the apparatus (100),

- controlling settings of the at least one acoustic deterrent emitter (200) according to the chosen deterrent action to emit a targeted deterrent acoustic signal to deter the identified woodpecker (400) species.

2. Apparatus (100) according to claim 1, wherein the acoustic sensors (111) of the at least one sensor array (110) are configured to register acoustic signal data of pecking that create vibrations propagating in the monitored structure (300) or associated parts.

3. Apparatus (100) according to claim 1, wherein the acoustic sensors (111) or control unit (120) is configured, by comprising means and software, to filter out soundwaves via the surrounding air that may disturb the acoustic sensor (111) measurements or deteriorate determination of the woodpecker (400) species or activity or both.

4. Apparatus (100) according to any preceding claim, wherein comprising a separate machine learning module (140) configured, by comprising means and software, or the control unit (120) is

configured, by comprising means and software, to perform machine learning, configured to, one or more of:

- process the registered acoustic signal data into datasets and classifying the datasets by performing machine learning of the acoustic signal data from the at least one sensor array (110) to improve the identification of the labelling/classification of the type of activity performed by the woodpecker (400) and if it is causing damage to the structure (300) or associated parts, or noise or both,

- determine the type of pecking activity of the involved woodpecker (400) species based on stored patterns or signatures unique for each activity in the same or separate database in the internal or external memory (130) of the apparatus (100),

- determine the woodpecker (400) species involved based on stored patterns or signatures unique for each woodpecker (400) species in the same or separate database in the memory (130) of the apparatus (100), and

- perform training using a set of historical acoustic signal data of woodpeckers (400) pecking and configured to adapt and update analysis and responses based on new sensor data as it is received.

5. Apparatus (100) according to any preceding claim, wherein the at least one acoustic deterrent emitter (200) is arranged on or near the monitored structure (300) and configured, by comprising at least one transducer or loudspeaker, emitting a deterrent signal in the form of natural sounds tailored to deter the identified woodpecker (400) species from causing further activity.

6. Apparatus (100) according to claim 5, wherein the at least one acoustic deterrent emitter (200) is activated based on the output of the separate machine learning module (140) or control unit (120), and is configured to be adjusted or disabled as needed.

7. Apparatus (100) according to any preceding claim, wherein the apparatus (100) is configured for real-time or near real-time monitoring and deterrent of woodpecker (400) damage and noise.

8. Method for acoustic deterrent targeting individual species of woodpeckers (400), wherein the method comprises:

- registering woodpecker (400) pecking on a structure (300) to be monitored or associated parts thereof, by at least one acoustic sensor array (110),

- determining the species of woodpeckers (400) involved and activity type of the involved woodpecker (400) species, based on comparing the registered acoustic signal data with patterns or signatures unique for each woodpecker species and activity type stored in at least one database,

- based on the determined woodpecker (400) species and type of activity, choosing a targeted deterrent action from available actions stored in the same or separate database, and

- controlling settings of at least one acoustic deterrent emitter (200) according to the chosen deterrent action to emit a targeted deterrent acoustic signal to deter the identified woodpecker (400) species.

9. Method according to claim 8, wherein the method comprising registering acoustic signal data of pecking that create vibrations propagating in the monitored structure (300) or associated parts.

10. Method according to claim 8, wherein the method further comprising filtering out soundwaves via the surrounding air that may disturb the acoustic sensor (111) measurements or deteriorate determination of the woodpecker (400) species or activity or both.

11. Method according to any preceding claim 8-10, wherein the method further comprising performing machine learning, comprising one or more of:

- processing the registered acoustic signal data into datasets and classifying the datasets by performing machine learning of the acoustic signal data from the at least one sensor array (110) to improve the identification of the labelling/classification of the type of activity performed by the woodpecker (400) and if it is causing damage to the structure (300) or associated parts, or noise or both,

- determining the type of pecking activity of the involved woodpecker (400) species based on stored patterns or signatures unique for each activity in the same or separate database,

- determining the woodpecker (400) species involved based on stored patterns or signatures unique for each woodpecker (400) species in the same or separate database, and

- performing training using a set of historical acoustic signal data of woodpeckers (400) pecking, and adapt and update analysis and responses based on new sensor data as it is received.

12. Method according to claim 11, wherein updating the settings of a control unit (120) controlling the at least one acoustic deterrent emitter (200) with updated settings from the machine learning steps.

Patentkrav

1. Innretning (100) for akustisk avskrekkelse rettet mot individuelle arter av hakkespetter (400) innrettet på eller nær en struktur (300) som skal overvåkes, hvori innretningen (100) omfatter et minst en sensoroppstilling (110) hvilken omfatter et flertall akustiske sensorer (111), en styringsenhet (120) og minst en akustisk avskrekkelsesemitter (200), hvori sensoroppstillingen (110) er konfigurert til å registrere akustiske signaldata av hakking fra hakkespetter på strukturen (300) eller assosierte deler,

hvori innretningen (100) omfatter en styringsenhet (120) konfigurert, ved å omfatte midler og programvare, til å:

- bestemme arten av hakkespetter (400) involvert basert på sammenligning av de registrerte akustiske signaldataene med mønstre eller signaturer unike for hver hakkespett (400) -art lagret i en database i et internt eller eksternt minne (130) av innretningen (100),

- bestemme typen aktivitet for den involverte hakkespetten (400) basert på sammenligning av de registrerte akustiske signaldataene med mønstre eller signaturer unike for hver type aktivitet lagret i den samme eller annen database i det indre eller eksterne minnet (130) av innretningen (100),

- basert på den bestemte hakkespett (400) -arten og typen aktivitet, velge en målrettet avskrekkelsesaksjon fra tilgjengelige avskrekkelsesaksjoner i den samme eller separat database i det interne eller eksterne minnet (130) av innretningen (100),

- styre innstillingene til den minst ene akustiske avskrekkelsesemitteren (200) i samsvar med den valgte avskrekkelsesaksjonen for å emittere et målrettet akustisk avskrekkelsessignal for å avskrekke den identifiserte hakkespett (400) -arten.

2. Innretning (100) i samsvar med krav 1, hvori de akustiske sensorene (111) til den minst ene sensoroppstillingen (110) er konfigurert til å registrere akustiske signaler av hakking som skaper vibrasjoner som propagerer inn i den overvåkede strukturen (300) og assosierte deler.

3. Innretning (100) i samsvar med krav 1, hvori de akustiske sensorene (111) eller styringsenheten (120) er konfigurert, ved å omfatte midler og programvare, til å filtrere ut lydbølger via den omgivende luften som kan forstyrre de akustiske sensor (111) -målingene eller forringe bestemmelsen av hakkespett (400) -arten eller aktiviteten eller begge.

4. Innretning (100) i samsvar med ett av de foregående krav, hvori den omfatter en separat maskinlæringsmodul (140) konfigurert, ved å omfatte midler og programvare, eller styringsenheten (120) er konfigurert, ved å omfatte midler og programvare, til å utføre maskinlæring, konfigurert til, en eller flere av:

- prosessere de registrerte akustiske signaldataene inn i datasett og klassifisere datasettene ved å utføre maskinlæring på de akustiske signaldataene fra den minst ene sensoroppstillingen (110) for å forbedre identifiseringen av merkingen/klassifiseringen av typen aktivitet som utføres av hakkespetten (400) og om den medfører skade på strukturen (300) eller assosierte deler, eller støy eller begge,

- bestemme typen hakkeaktivitet for den involverte hakkespett (400) -arten basert på lagrede mønstre eller signaturer unike for hver aktivitet i den samme eller separat database i det interne eller eksterne minnet (130) av innretningen (100),

- bestemme hakkespett (400) -arten involvert basert på lagrede mønstre eller signaturer unike for hver hakkespett (400) -art i den samme eller separat database i minnet (130) av innretningen (100), og

- utføre trening ved bruk av et sett med historiske akustiske signaldata av hakkespetter (400) som hakker og konfigurert til å tilpasse analyser og responser basert på nye sensordata ettersom de mottas.

5. Innretning (100) i samsvar med ett av de foregående krav, hvori den minst ene akustiske avskrekkelsesemitteren (200) er innrettet på eller nær den overvåkede strukturen (300) og konfigurert, ved å omfatte minst en transduser eller høyttaler, til å emittere et avskrekkelsessignal i form av naturlige lyder skreddersydd for å avskrekke den identifiserte hakkespett (400) -arten fra å utføre ytterligere aktivitet.

6. Innretning (100) i samsvar med krav 5, hvori den minst ene akustiske avskrekkelsesemitteren (200) aktiveres basert på utdata fra den separate maskinlæringsmodulen (140) eller styringsenheten (120), og er konfigurert til å bli justert eller deaktivert etter behov.

7. Innretning (100) i samsvar med ett av de foregående krav, hvori innretningen (100) er konfigurert for sanntids eller nær sanntids overvåkning og avskrekkelse av hakkespett (400) -skade og støy.

8. Fremgangsmåte for akustisk avskrekkelse rettet mot individuelle arter av hakkespetter (400), hvori fremgangsmåten omfatter:

- registrering av hakkespett (400) -hakking på en struktur (300) som skal overvåkes eller assosierte deler derav, ved minst en akustisk sensoroppstilling (110),

- bestemme arten av hakkespetter (400) involvert og aktivitetstype for den involverte hakkespett (400) -arten, basert på sammenligning av de registrerte akustiske signaldataene med mønstre og signaturer unike for hver hakkespettart og aktivitetstype lagret i minst en database,

- basert på den bestemte hakkespett (400) -arten og type aktivitet, velge en målrettet avskrekkelsesaksjon fra tilgjengelige aksjoner i den samme eller separat database, og

- styre innstillingen til minst en akustisk avskrekkelsesemitter (200) i samsvar med den valgte avskrekkelsesaksjonen for å emittere et målrettet akustisk signal for å avskrekke den indentifiserte hakkespett (400) -arten.

9. Fremgangsmåte i samsvar med krav 8, hvori fremgangsmåten omfatter registrering av akustiske signaldata av hakking som skaper vibrasjoner i den overvåkede strukturen (300) eller assosierte deler.

10. Fremgangsmåte i samsvar med krav 8, hvori fremgangsmåten omfatter utfiltrering av lydbølger via den omgivende luften som kan forstyrre de akustiske sensor (111) -målingene eller forringe bestemmelsen av hakkespett (400) -arten eller aktiviteten eller begge.

11. Fremgangsmåte i samsvar med ett av kravene 8-10, hvori fremgangsmåten videre omfatter utføring av maskinlæring, omfattende en eller flere av:

- prosessere de registrerte akustiske signaldataene inn i datasett og klassifisering av datasettene ved utføring av maskinlæring av de akustiske signaldataene fra den minst ene sensoroppstillingen (110) for å forbedre identifiseringen av merkingen/klassifiseringen av typen aktivitet utført av hakkespetten (400) og om den medfører skade på strukturen (300) eller assosierte deler, eller støy eller begge,

- bestemme typen hakkeaktivitet for den involverte hakkespett (400) -arten basert på lagrede mønstre eller signaturer unike for hver aktivitet i den samme eller separat database,

- bestemme hakkespett (400) -arten involvert basert på lagrede mønstre eller signaturer unike for hver hakkespett (400) -art i den samme eller separat database, og

- utføre trening ved bruk av et sett med historiske akustiske signaldata av hakkespetter (400) som hakker, samt tilpasse og oppdatere analyser og responser basert på nye sensordata ettersom de mottas.

12. Fremgangsmåte i samsvar med krav 11, hvori oppdatere innstillingene til en styringsenhet (120) hvilken styrer den minst ene akustiske avskrekkelsesemitteren (200) med oppdaterte innstillinger fra maskinlæringstrinnene.

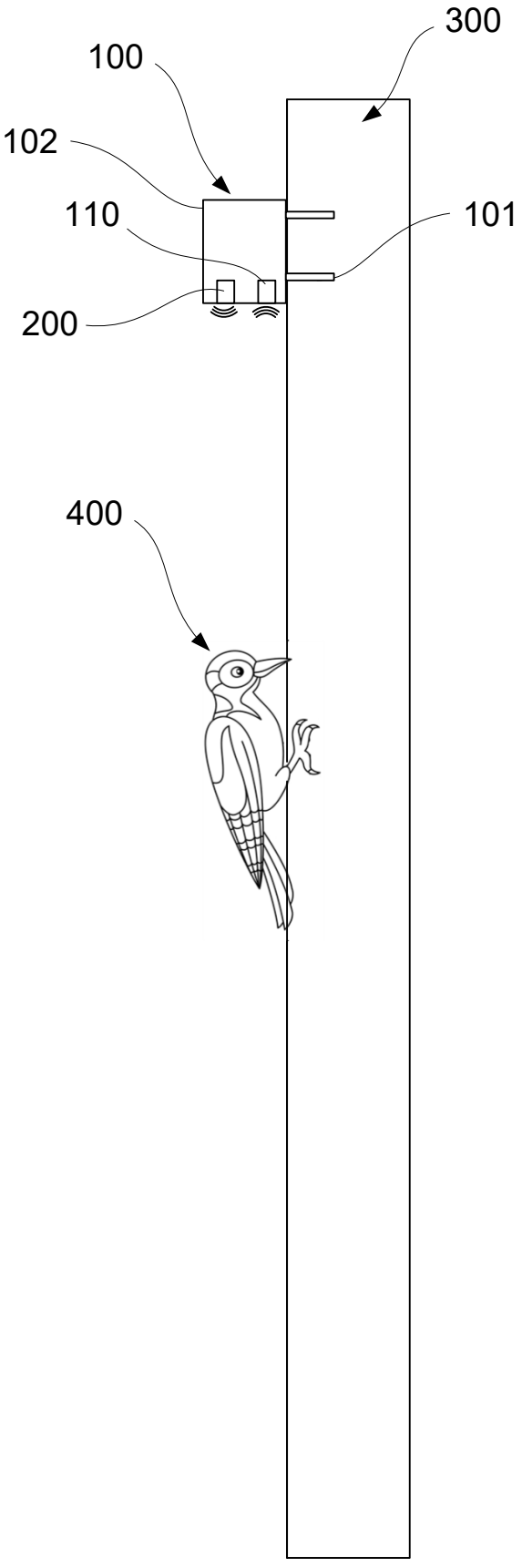


Fig. 1a.

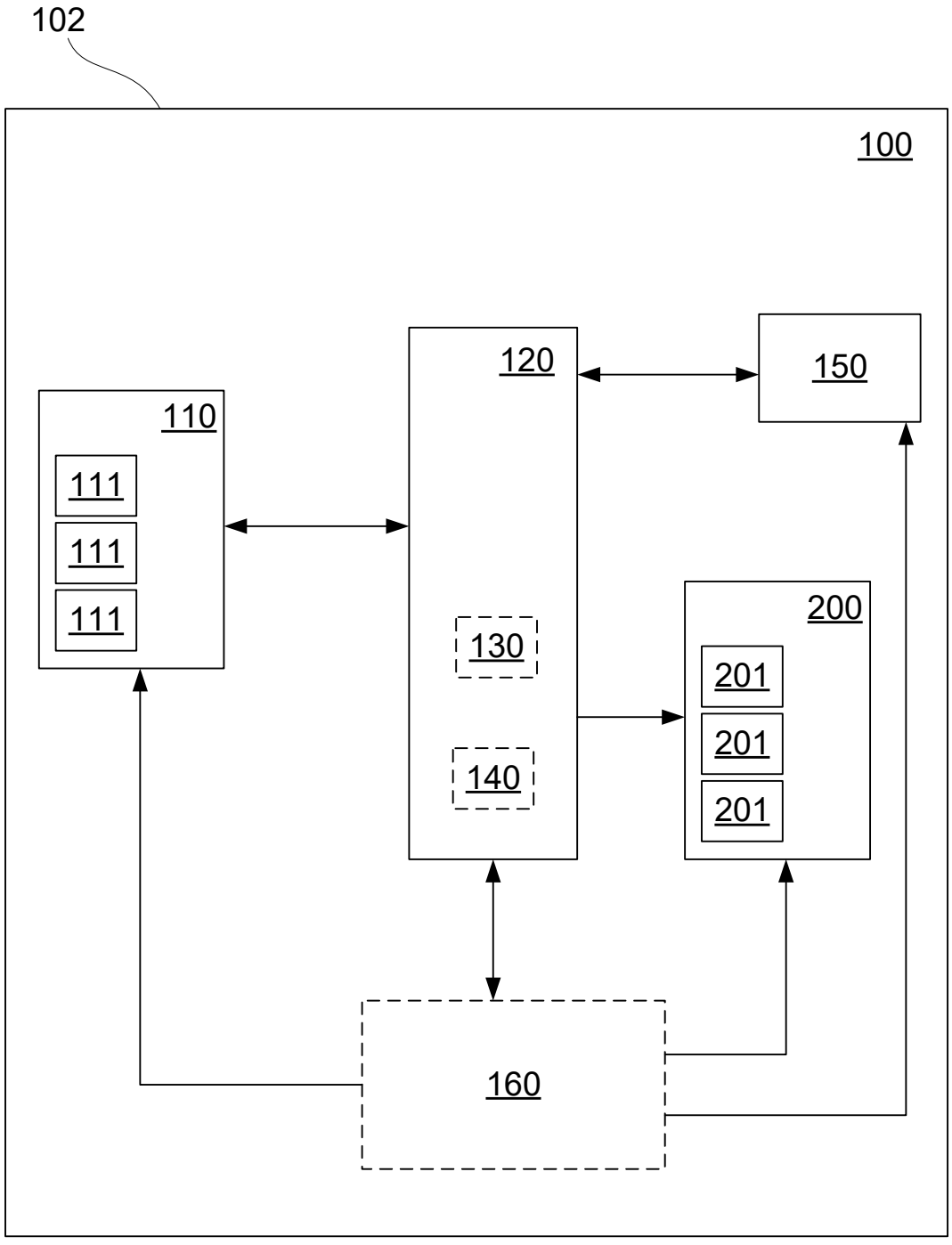


Fig. 1b.

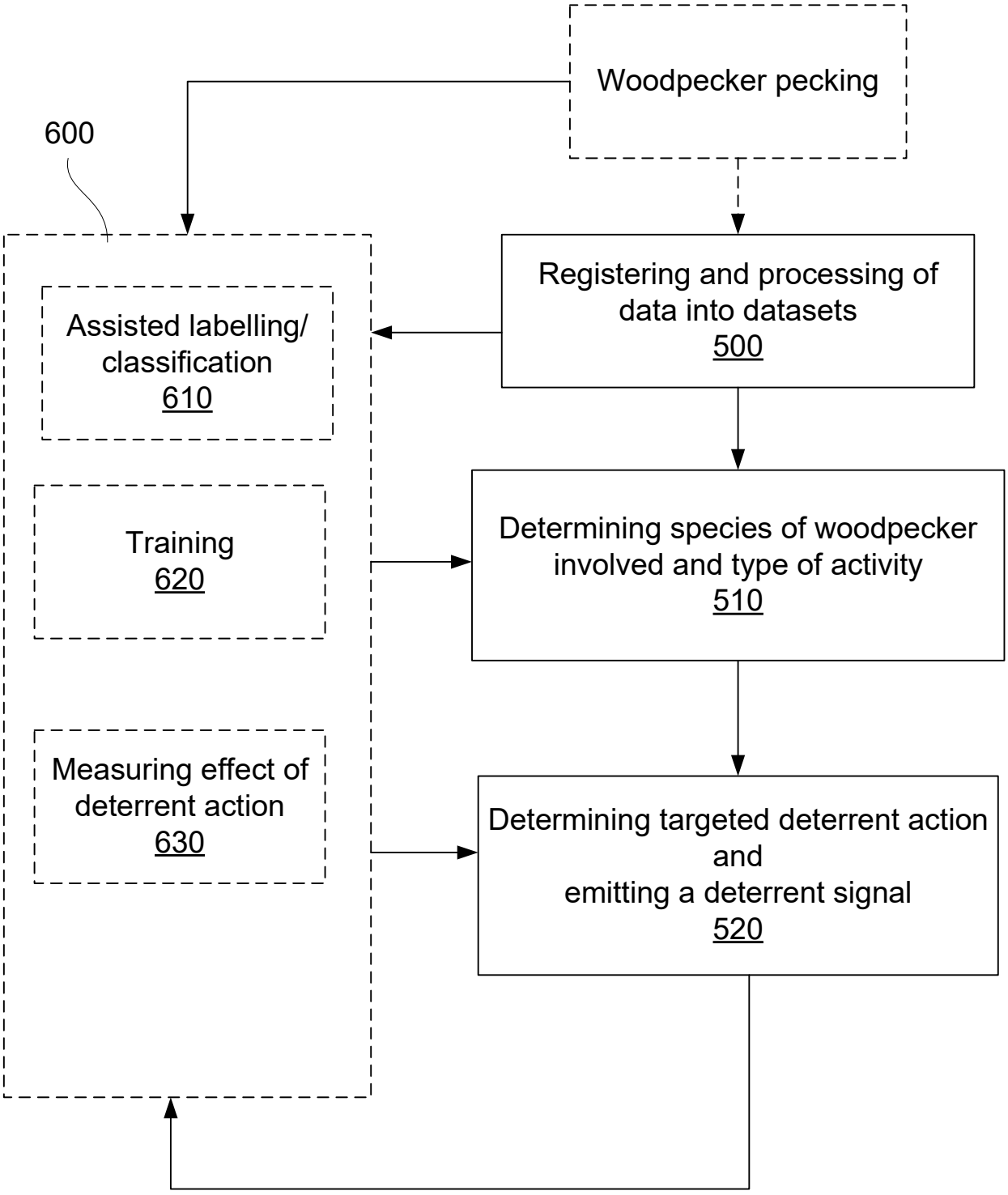

Woodpecker pecking
600
Registering and processing of data into datasets
500
Assisted labelling/ classification
610
Training
620
Measuring effect of deterrent action
630
Determining species of woodpecker involved and type of activity
510
Determining targeted deterrent action and emitting a deterrent signal
520

Fig. 2.