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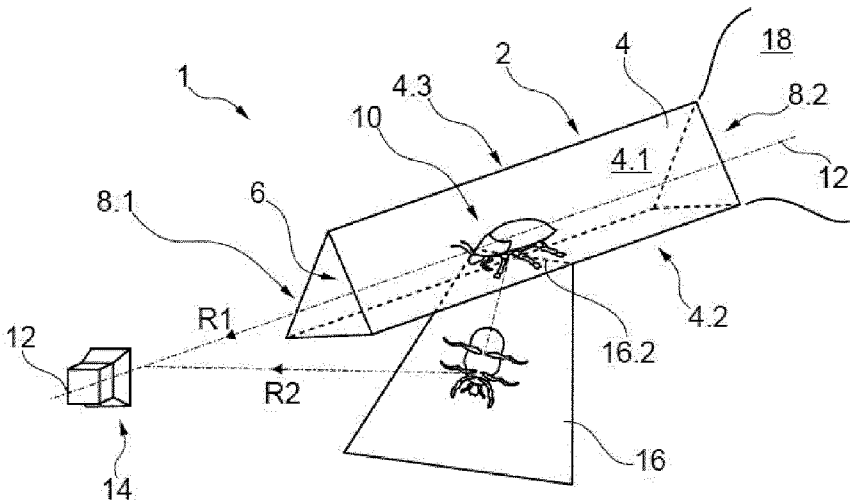
(54) Title: SYSTEM AND METHOD FOR SURVEYING AND/OR MONITORING ANIMALS

[Fig. 1]



(57) Abstract: The invention is directed to a system (1) for capturing images of animal specimens (10) comprising: a tube (2) having a transparent peripheral wall (4) delimiting a channel (6); a camera (14) facing the tube (2); and at least one mirror (16) arranged in the field of view of the camera (14) and offset away from the central axis (12), the at least one mirror (16) being arranged with respect to the camera (14) and with respect to the tube (2) such as to enable the camera (14) to capture, via the at least one mirror (16) and through the transparent wall (4), an offset image portion (24, 26, 28) of the specimen (10) present in the channel (6). The camera (14) also captures another view of the specimen, either through an open end of the tube (2), through an elbow-like portion of the tube (2) or via a second mirror (16).

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Description

Title of Invention: SYSTEM AND METHOD FOR SURVEYING AND/OR MONITORING ANIMALS

Technical Field

[0001] The invention is directed to a system and a method for surveying and/or monitoring populations of animals and in particular flying insects.

Background Art

[0002] Observing wildlife has always been challenging, mainly because the animals move over vast territories and are sometimes afraid of human beings.

[0003] Imaging technologies have been used for observing vertebrates by placing a digital camera at one location in an environment (forest, desert, etc.) over a defined period of time and subsequently analysing the recorded images or videos to identify the animals that passed in front of the camera. This method has limitations as it only senses animals that have actually passed in front of the camera. Also, many images are blurry because the auto-focus system of a camera may be noisy and it sometimes frightens the animals, leading the animals to run/fly away even before the camera can shoot a sharp picture of them.

[0004] For monitoring smaller animals, such as insects or other invertebrates, the difficulties are even bigger. The most common methods that are used to survey or monitor a population of insects and/or other invertebrates are lethal: specimens are collected (or attracted) using a range of tools such as Malaise trapping, light trapping, pan trapping, pitfall trapping, beating sheets, hand nets, etc., and are often subsequently killed and identified in a laboratory. After having been identified, the specimens are further processed (long-term preservation involving chemicals), or discarded. Beyond the ethical and ecological controverse, these methods also involve the cost of collecting, processing, and managing the specimens. In addition, these lethal measurements can be disruptive as they may impact the populations that one desires to monitor.

[0005] Moreover, collecting small animals (insects, other arthropods, amphibians) and monitoring changes in a population is time consuming: it requires a repetitive collection of occurrence or abundance data. The reliability of the measurements lies in the frequency of visits to the studied area(s) for collecting sufficient data throughout the year, since the species are not all active at the same period. The amount of time and effort needed considerably increases with the size of the area to be surveyed.

[0006] Recent technologies have been developed to facilitate the collection of data by reducing the effort and expenses incurred by monitoring the species, namely ento-mological radar/lidar, or infrared sensors, optoelectronics, automatic acoustic

monitoring, wing-beat frequency or eDNA.

[0007] Presumably inspired by the observations of vertebrates discussed above, camera-based monitoring technologies have been developed for automatically collecting insect occurrence or abundance data, especially in the field of agriculture (e.g., for pests), but also for non-pest flying insect monitoring, particularly flying nocturnal insects. However, non-lethal image-based monitoring methods do not offer the level of reliability that lethal methods offer because a picture of a flying insect will often not be of sufficiently high quality to permit the identification of the insect with a sufficiently high taxonomic resolution: either the image is blur due to the motion of the insect, or the camera has a sufficiently high shutter speed to capture a sharp image but the brightness is then insufficient. Also, a picture will often not show an individual insect but will show other insects of the same or other species, and/or mud or dust.

[0008] An example of an image-based technology is discussed in the document WO 2012/054990 A1, which shows a device that is sized to force an insect to walk in front of a camera. This system does not offer a sufficient reliability for the identification of the majority of insects at a high taxonomic resolution or the identification of an individual within a given species.

Summary of Invention

Technical Problem

[0009] The invention aims at providing a system and a method which enable to survey or monitor animal specimens in a less cumbersome and more reliable manner.

Technical solution

[0010] The invention relates to a system for capturing images of animal specimens comprising: an open-ended straight tube having a transparent peripheral wall delimiting a channel, the channel having a central axis; a camera facing an open end of the tube and aligned with the tube such that the optical axis of the camera coincides with the central axis of the channel, thereby enabling the camera to capture, through the open end, a central image portion of a specimen present in the channel; and at least one mirror arranged in the field of view of the camera and offset away from the central axis, the at least one mirror being arranged with respect to the camera and with respect to the tube such as to enable the camera to capture, via the at least one mirror and through the transparent wall, an offset image portion of the specimen present in the channel. The camera is preferably located outside of the tube.

[0011] The system enables therefore to obtain at least two pictures, from two different points of view (or orientations), of a given specimen. This makes it possible to gather at once (simultaneously or within a short amount of time) enough information for obtaining a reliable identification of the specimen.

[0012] In the present document, the wording "identification of a specimen" refers to the identification of a species (of insect for instance) which the specimen belongs to, or the identification of the specimen as being a particular individual within the species. Additionally, "identification of a specimen" may also entail the determination of particular properties of the specimen that is in the channel: physiological details (sex, dimensions), health condition (potential injuries or diseases, reproductive condition, etc.), presence of a (natural or artificial) mark (e.g., used in capture-mark-recapture studies) or a transponder, etc.

[0013] Although the present invention has particular advantages when used for surveying/monitoring insects, the system may be sized to observe various other species, including other invertebrates, small vertebrates (such as amphibians) or large vertebrates. This may be useful in various contexts, including but not limited to the monitoring of the impact of human activities on biodiversity.

[0014] In the present invention, unless otherwise specified, the word "tube" is used to depict a generic hollow shape being straight in at least a portion thereof, and having a circular, elliptic or polygonal cross-section.

[0015] The invention also relates to a system for capturing images of animal specimens comprising: a tube having a transparent peripheral wall delimiting a channel, the tube having a straight portion and an elbow-like portion; and either a camera facing the elbow-like portion, thereby enabling the camera to capture, through the elbow-like portion, a central image portion of a specimen present in the channel; and at least one mirror arranged in the field of view of the camera, the at least one mirror being arranged with respect to the camera and with respect to the tube such as to enable the camera to capture, via the at least one mirror and through the transparent wall, an offset image portion of the specimen present in the channel; or a camera facing the elbow-like portion; and at least two mirrors arranged in the field of view of the camera and arranged with respect to the camera and with respect to the tube such as to enable the camera to capture, via the at least two mirror and through the transparent wall, two respective offset image portions of the specimen present in the channel. The camera is preferably located outside of the tube.

[0016] According to an advantageous embodiment, the peripheral wall of the tube and/or of the straight portion of the tube and/or of the elbow-like portion of the tube has a polygonal cross-section and the at least one mirror or the at least two mirrors comprise as many mirrors as the number of edges of the polygonal cross-section. Alternatively, the number of mirrors may be different from the number of edges of the polygonal cross-section (e.g., two or more mirrors and a cylindrical tube, two mirrors on a triangular tube, etc.). According to an advantageous embodiment, the polygonal cross-section is triangular and the at least one mirror is constituted of three mirrors. The

triangular shape may or may not be equilateral. The number of mirrors directly impacts the amount of data that can be extracted from the image and therefore the reliability of the specimen identification.

[0017] According to an advantageous embodiment, the at least one mirror is inclined with respect to the central axis at an angle that is comprised between 20° and 80°, preferably between 45° and 60°. The angle of the mirror impacts the optical path of the light rays reaching the camera and originating from the specimen, and therefore the difference in depth of field between the central image portion and the offset image portion. The angle also impacts the overall bulkiness of the system.

[0018] According to an advantageous embodiment, the at least one mirror has an edge that is parallel to, or in contact with, the wall of the channel. This avoids optical interferences (e.g., artifacts or chromatic aberration) and hence enables a more reliable identification of the specimen.

[0019] According to an advantageous embodiment, the at least one mirror has a surface area that is at least four times the surface area of the cross section of the peripheral wall. Because most of the animals are longer than they are tall, this ratio enables to obtain, for each portion of the image, a complete representation of the specimen, ensuring a reliable identification.

[0020] According to an advantageous embodiment, the depth of field of the camera is sufficiently deep for the specimen to be in focus simultaneously on the central image portion and on the offset image portion(s); and/or the camera is equipped with an in-camera focus stacking function; and/or the camera is programmed to build a composite image by juxtaposing the central image portion and the offset image portion(s).

[0021] Because some animals may move fast, the shutter speed of the camera may need to be high (e.g., faster than 1/1000 s), limiting the amount of light reaching the camera. This lack of light may be compensated by setting a wide aperture up to the limit dictated by the depth of field which must remain sufficient to obtain sharp (or sharp enough) representations both in the central image portion and the offset image portion(s). The limited amount of light may also be compensated by external lightning: a flash or a projector (in visible light or infrared).

[0022] According to an advantageous embodiment, the system further comprises a device for attracting and/or intercepting and/or collecting animals, such as a vane trap or a Malaise trap, the device being arranged to direct the animal specimens into the channel. The device may be such that the specimen travels in the channel towards the camera, the central image portion capturing consequently a front "face" of the specimen. Alternatively, the trap may encourage the specimen to travel in the channel away from the camera, the central image portion thereby capturing the back of the specimen.

[0023] The invention also relates to an assembly for surveying or monitoring animals over a geographical area, the assembly comprising a plurality of systems as described above that are distributed over the geographical area; and a computing device connected to the plurality of systems for receiving the images shot by the respective cameras.

[0024] An array/network of many of such multiple-view image capturing devices allows for higher taxonomical resolution data to be simultaneously collected across a large spatiotemporal scale.

[0025] The various monitoring systems of this network may use different traps or filters, to attract or restrict the access of their channels to specific species.

[0026] The invention also relates to a method for surveying or monitoring animals comprising: capturing images of animal specimens with a system or an assembly as described above; and identifying the animal specimens appearing on the captured images.

[0027] According to an advantageous embodiment, the central image portion and the offset image portion(s) are captured simultaneously. This constitutes an efficient way (both in capturing time, processing time and amount of data collected) to reliably identify the specimen.

[0028] Alternatively, the method may comprise building a composite image by blending a primarily captured central image portion with a subsequently captured offset image portion(s). Alternatively, the central image portion can originate from an image shot later than the offset image portions. This enables to blend several sharp images of the same specimen, ensuring a reliable identification.

[0029] According to an advantageous embodiment, the identification of the animal specimen is performed by a computer-implemented image recognition technique optionally using a specifically trained convolutional neural network. The neural network may be trained specifically for some given branches of the taxonomy, e.g., insects. The efficiency of the analysis is improved by the use of a neural network since images can be automatically processed, with great potential for passive animal monitoring, and with a potential for continuous improvement of the reliability of the analysis.

[0030] According to an advantageous embodiment, the method comprises a step of construction of a 3D model of the animal specimens based on the captured images and potential extrapolations. The various points of view of the specimen and potentially the merging of several successive images enable the generation of a 3D model of the specimen. This 3D model can then be used to enrich the database and/or to feed the neural network, for improving forthcoming identifications.

Advantages of the invention

[0031] Overall, the various aspects of the invention propose a non-lethal efficient way (in terms of time, human effort, or cost) to improve the reliability of the identification of

animals.

[0032] The invention is particularly interesting because it enables to obtain multiple representations of a specimen, seen from multiple points of view, while ensuring that it is effectively the same specimen that is shot by the camera. The risk that may exist with other systems to mix up several images of different specimens is avoided.

[0033] The invention may be programmed to continuously collect high resolution images for a range of animals, thus increasing the temporal resolution of data, while reducing the need for repeated field visits or the necessity to empty traps (collection bottles of lethal traps). The invention permits to reduce the number of visits to a study area(s) and to nullify the required time spent to sort samples of dead insect. The system of the invention can be left on site throughout a sampling period without the need for any maintenance.

[0034] The invention does not disturb the animals, as it does not produce sound or chemicals. The invention does not disturb a population, as it is not lethal.

[0035] The system is not complex and can be implemented without technical difficulties and for a limited cost.

[0036] The use of artificial intelligence methods and/or a series of systems connected as a network increases the possibilities to monitor a wide range of species over a large geographical area and over a long duration. This constitutes a stark contrast to known post-analysis methods where hundreds of specimens are collected with traditional lethal methods and then analysed in a laboratory.

Brief description of the drawings

[0037] [Fig.1] shows an isometric view of the system of the invention;

[0038] [Fig.2] shows a side view of the system of the invention;

[0039] [Fig.3] shows an example of an image captured by the camera;

[0040] [Fig.4] shows an assembly of systems of the invention.

Description of an embodiment

[0041] The drawings show some features of the invention in a schematic way. The figures are not drawn to scale and some dimensions may be enlarged for a better understanding of the concepts of the invention.

[0042] [Fig.1] shows an example of a system 1 for surveying or monitoring animal specimens.

[0043] The system 1 comprises a straight tube 2 having a peripheral wall 4 delimiting an inner cavity, i.e., a channel 6. The tube 2 has two open ends 8.1, 8.2 for letting a specimen 10 enter and exit the channel 6. The person skilled in the art will recognize that the “tube” may also be called “channel”, “tunnel”, “passage”, “path”, “duct”, “pipe”, “route”, “conduit”.

[0044] The tube 2, or its channel 6, defines an axis 12. The axis 12 may be a line connecting the geometric centres of gravity of the successive cross-sections of the tube 2. Alternatively, the axis 12 may be a preferential axis of the channel 6 that is parallel to the wall 4 of the tube 2 and that is positioned at an appropriate location with respect to an expected position of the specimen 10: for a walking animal, axis 12 may be close to the bottom of the channel 6.

[0045] The peripheral wall 4 may have a polygonal cross-section. In this example, the polygon is a triangle. Other polygons (square, rectangle, pentagon, hexagon, etc.) can be used as well, the wall 4 being thus made of any number of flat sides 4.1, 4.2, 4.3. Other regular or irregular shapes can be foreseen for the cross-section of the wall 4, such as, an ellipse, a circle, or a random non-geometrical shape.

[0046] The peripheral wall 4 is at least partially transparent (e.g., it is not fully opaque) and can be made of glass, acrylic glass, PMMA, Plexiglas® or other (at least partially) transparent material.

[0047] When the system is used for monitoring insects, the tube may be between 50 and 300 mm long, for instance around 120 mm. It can be between 5 and 50 mm high, for instance 22 mm.

[0048] The system 1 further comprises a camera 14 which is arranged such that the optical axis of the camera 14 coincides with the axis 12 of the channel 6. The camera 14 may be a digital camera and may be able to capture single images, or multiple images (rafale), or videos. The camera 14 may be equipped with appropriate lens, e.g., macro lens when observing small animals. The camera 14 may capture visible and/or infrared light.

[0049] The camera 14 may integrate additional functions, such as a projector or a flash (in visible and/or infrared light).

[0050] The camera 14 is connected or connectable to computing means which can analyse the images taken by the camera so as to identify the specimens captured by the camera 14.

[0051] The camera 14 faces an open end 8.1 of the tube and can therefore see and capture the specimen 10. In the example shown, the insect is moving towards the camera 14 and the camera 14 captures the front face of the specimen 10. A light ray R1, coinciding with axis 12 illustrates this direct capture of the specimen 10 by the camera 14. In an alternative example (not shown), the camera 14 does not face an open end of the tube 2 but rather an elbow-like shape.

[0052] The system 1 further comprises at least one mirror 16 that is placed in the field of view of the camera 14. The mirror 16 is inclined with respect to the axis 12. The arrangement of the tube 2, the camera 14 and the mirror 16 is such that the camera 14 can capture a view of the specimen 10 by reflection on the mirror 16 and through the

transparent wall 4. A light ray R2 illustrates this principle. The reader will understand that the mirror 16 can be more or less inclined and can be brought towards or away from the camera, while still providing a view of the specimen 10 that is visible for the camera 14. Thus, although the mirror is illustrated in about the middle of the tube 2, alternative positions may be envisaged, further or closer to the camera.

[0053] The mirror 16 may have a polygonal shape and is preferably flat. Each side of the polygon can be of approximately 50 mm. It can be for instance a rectangle (or quadrangle) and can have an edge 16.2 that is parallel or in contact with a flat side 4.2 of the wall 4. The fact that the sides 4.1, 4.2, 4.3 of the wall 4 are flat can be advantageous for obtaining a good optical quality. Also, the edge 16.2 in contact or parallel and close to the wall 4 may be advantageous to prevent any artefact or unwanted light from reaching the camera.

[0054] The surface area of the mirror 16 may be at least four times greater than the surface area of the cross-section of the wall 4. Because most animals are longer than they are tall, this ratio enables to obtain a complete representation of the animals in the indirect view captured via the mirror 16.

[0055] Due to the difference of length between the light ray R1 and the light ray R2, the camera 14 may need to ensure that both the direct and indirect representations of the specimen 10 are in focus. This may be done by choosing a camera setting (aperture) that offers a large enough depth of field (for instance a depth of field of at least 3 cm). Alternatively, the camera 14 may be equipped with in-camera focus stacking function, which processes the image to correct their sharpness. Otherwise, the camera 14 (or an integrated or remote processing means) can blend successive images together to form a single image composed of two or more independently taken sharp representations of the specimen 10.

[0056] Although one mirror 16 is illustrated on [Fig.1], the system 1 may comprise more than one mirror 16. In particular, there may be as many mirrors as there are edges of the polygonal shape of the wall 4. If three mirrors may be sufficient to identify most of the species, more than three mirrors may be needed in some cases.

[0057] The mirrors 16 may all be arranged at the same distance to the camera 14, although an alternative design can foresee mirrors 16 arranged at distinct distances to the camera 14. This may be advantageous for rendering the system more compact locally.

[0058] The system 1 may comprise additional sensors, for instance with the aim to correlate the presence of various specimens to other conditions, or to better classify the specimens that are detected. Namely, the system 1 can comprise a temperature sensor, a pressure sensor, a hygrometry sensor, a luxmeter and/or a microphone.

[0059] The camera 14 can be triggered to take pictures upon detection of the presence of a specimen in the tube 2. Motion detectors or other types of sensors can be used.

[0060] The system 1 can further comprise an appropriate device 18 that attracts the specimens and conduct them into the channel 6. The device 18 may be species-dependent and may be known as such (vane trap, Malaise trap, etc.). The device 18 may contain a funnel and/or a one-way door that directs the specimens into the channel 6 and towards the camera 14.

[0061] [Fig.2] shows a side view of the system 1 of [Fig.1]. This figure shows the boundaries 14.1, 14.2 of the vertical field of view of the camera 14. Any point above or below these boundaries is not seen by the camera 14. Similar boundaries to the (horizontal) field of view exist in a transverse direction. The mirror(s) 16 is/are positioned in the field of view of the camera 14.

[0062] [Fig.2] also shows the inclination α of the mirror 16 with respect to the axis 12. This angle α can be comprised between 20 and 80°. Advantageously, the angle is comprised between 45° and 60°.

[0063] [Fig.3] shows an image 20 as seen by the camera 14, in a configuration where the system comprises a triangular channel 6 and three mirrors 16.

[0064] The image 20 contains a central image portion 22 representing the specimen 10 in a direct view.

[0065] The image 20 further comprises several offset image portions 24, 26, 28 representing the specimen 10 in an indirect view, after reflexion on the mirrors 16 and through the transparent wall 4.

[0066] [Fig.3] shows that the arrangement of mirrors 16 enables to capture at the same time several representations of the specimen 10 under different orientations.

[0067] The camera 14 can take successive shots. If, for some reasons, one portion (for instance the offset portion 24) of the image is of low quality (blurry), the camera 14 or post-processing means can blend a portion of higher quality taken from a previous or successive shot. This enables a single (composite) image 20 to contain all relevant information to identify the specimen 10.

[0068] The camera 14 may also record a video with the aim of collecting additional information (gait or movement of the specimen 10).

[0069] The images 20 taken by the camera 14 can be stored and analysed. Use can be made of the various portions of the images 20. In particular, the shape, the sizes, the colours, the textures may be used to identify the specimen. Also, the kinematic of portions of the specimen between successive images may be used.

[0070] They can be analysed automatically by an image-recognition tool. For instance, a specifically trained convolutional neural network can be used.

[0071] The neural network can be trained by being fed with images 20. Each image is made of as many tuples as the number of portions of the system (4 in the example of [Fig.3]). Since each image 20 combines a high quantity of information in a small amount of

volume, the training of the neural network can be very efficient. Beyond the fact that an image 20 contains several points of views of a single species, it also contains various aspects of a single individual of the species. The neural network can therefore be used, not only for recognizing species, but also for recognizing a particular individual, if such individual has already passed through the tube.

[0072] The system 1 may also contain a computing device that generates a 3D model of the specimen based on the captured images. The 3D model can be built by extrapolating various portions of a given image 20 and/or can make use of several successive images 20 of the same specimen. "Image depth map" techniques (or time-of-flight) may be used to assist the extrapolation of the images for building a 3D model.

[0073] The 3D model can be articulated in the sense that the successive images 20 (or videos) can detect which subparts of the specimen constitute a kinematical unit and which kind of kinematic movements are permitted between the various units.

[0074] In an alternative embodiment (not shown), the camera 14 does not face an open end of the tube 2. For example, the tube 2 can have an elbow-like portion. In such a case, the central portion 22 can either be seen through the transparent wall of the elbow-like portion, or the image 20 can be void of central portion 22. In this latter case, the invention may contain at least two mirrors 16 to ensure that the camera 14 is enabled to capture at least two distinct views of the specimen. The elbow-like portion may have a different cross-section (for instance circular cross-section) than the straight portion (for example triangular) of the tube. The optical axis of the camera 14 may or may not be aligned with the central axis of the straight portion. As the mirrors alone provide the different views on the specimen, the tube itself does not need to be within the field of view of the camera in that example. Also, the tube 2 may not have a straight portion at all.

[0075] [Fig.4] schematically shows an example of an assembly 100 of systems 1, arranged as a network to survey or monitor a given geographical area 110. The various systems 1 may be connected (in parallel or series) to a common computing device 120 to collect images and analyse the species present in the geographical area 110. The connection may be wireless.

[0076] Although the preferred application of the invention is directed to (flying) insects, the invention can also be used for other, larger or smaller animals, including other invertebrates or small vertebrates. Also, the invention can be implemented in hostile environment or under water to survey aquatic fauna (for example aquatic invertebrates or fish).

[0077] Although the recognition of "species" is mentioned in the present application, the system of the invention is also able to identify higher taxonomic levels, such as the "genus", the "family", the "order", the "class", or the "phylum" of the specimen.

Claims

[Claim 1] A system (1) for capturing images (20) of animal specimens (10) comprising:
- an open-ended straight tube (2) having a transparent peripheral wall (4) delimiting a channel (6), the channel (6) having a central axis (12);
- a camera (14) facing an open end (8.1) of the tube (2) and aligned with the tube (2) such that the optical axis of the camera (14) coincides with the central axis (12) of the channel (6), thereby enabling the camera (14) to capture, through the open end (8.1), a central image portion (22) of a specimen (10) present in the channel (6); and
- at least one mirror (16) arranged in the field of view of the camera (14) and offset away from the central axis (12), the at least one mirror (16) being arranged with respect to the camera (14) and with respect to the tube (2) such as to enable the camera (14) to capture, via the at least one mirror (16) and through the transparent wall (4), an offset image portion (24, 26, 28) of the specimen (10) present in the channel (6).

[Claim 2] A system (1) for capturing images (20) of animal specimens (10) comprising:
- a tube (2) having a transparent peripheral wall (4) delimiting a channel (6), the tube (2) having a straight portion and an elbow-like portion; and

either

- a camera (14) facing the elbow-like portion, thereby enabling the camera (14) to capture, through the elbow-like portion, a central image portion (22) of a specimen (10) present in the channel (6); and
- at least one mirror (16) arranged in the field of view of the camera (14), the at least one mirror (16) being arranged with respect to the camera (14) and with respect to the tube (2) such as to enable the camera (14) to capture, via the at least one mirror (16) and through the transparent wall (4), an offset image portion (24, 26, 28) of the specimen (10) present in the channel (6);

or

- a camera (14) facing the elbow-like portion; and
- at least two mirrors (16) arranged in the field of view of the camera (14) and arranged with respect to the camera (14) and with respect to the tube (2) such as to enable the camera (14) to capture, via the at least two mirror (16) and through the transparent wall (4), two respective

offset image portions (24, 26, 28) of the specimen (10) present in the channel (6).

[Claim 3] System (1) according to claim 1 or 2, characterized in that the peripheral wall (4) of the tube (2) and/or of the straight portion of the tube (2) and/or of the elbow-like portion of the tube (2) has a polygonal cross-section and the at least one mirror (16) or the at least two mirrors (16) comprise as many mirrors (16) as the number of edges of the polygonal cross-section.

[Claim 4] System (1) according to claim 3, characterized in that the polygonal cross-section is triangular and the at least one mirror (16) is constituted of three mirrors (16).

[Claim 5] System (1) according to any of claims 1-4, characterized in that the at least one mirror (16) is inclined with respect to the central axis (12) at an angle (α) that is comprised between 20° and 80°, preferably between 45° and 60°.

[Claim 6] System (1) according to any of claims 1-5, characterized in that the at least one mirror (16) has an edge (16.1, 16.2, 16.3) that is parallel to, or in contact with, the peripheral wall (4).

[Claim 7] System (1) according to any of claims 1-6, characterized in that the at least one mirror (16) has a surface area that is at least four times the surface area of the cross section of the peripheral wall (4).

[Claim 8] System (1) according to any of claims 1-7, characterized in that the depth of field of the camera (14) is sufficiently deep for the specimen (10) to be in focus simultaneously on the central image portion (22) and on the offset image portion(s) (24, 26, 28); and/or wherein the camera (14) is equipped with an in-camera focus stacking function; and/or wherein the camera (14) is programmed to build a composite image by juxtaposing the central image portion and the offset image portion(s).

[Claim 9] System (1) according to any of claims 1-8, characterized by further comprising a device (18) for attracting and/or intercepting and/or collecting animals, such as a vane trap or a Malaise trap, the device (18) being arranged to direct the animal specimens (10) into the channel (6).

[Claim 10] Assembly (100) for surveying or monitoring animals over a geographical area (110), the assembly (100) comprising a plurality of systems (1) according to any of claims 1 to 9 that are distributed over the geographical area (110); and a computing device (120) connected to the plurality of systems (1) for receiving the images (20) shot by the re-

spective cameras (14).

[Claim 11] Method for surveying or monitoring animals comprising:
- capturing images of animal specimens (10) with a system (1) according to any of claims 1 to 9 or with an assembly (100) according to claim 10; and
- identifying the animal specimens (10) appearing on the captured images (20).

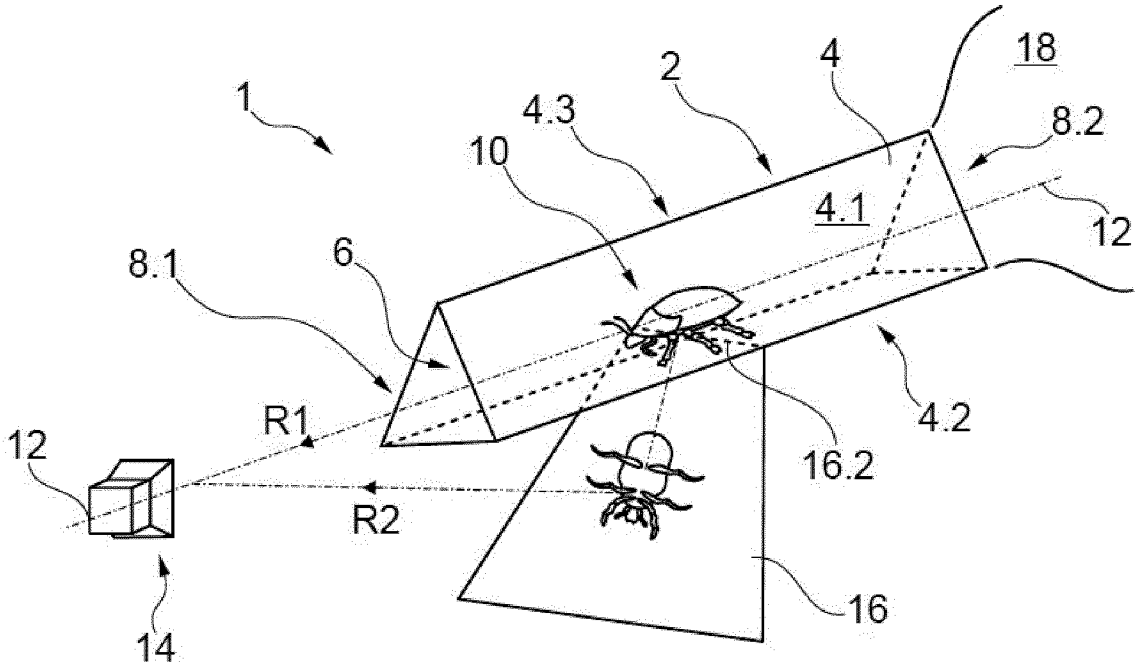
[Claim 12] Method according to claim 11, characterized in that the central image portion (22) and the offset image portion(s) (24, 26, 28) are captured simultaneously.

[Claim 13] Method according to claim 11, characterized by further comprising building a composite image by blending a primarily captured central image portion (22) with a subsequently captured offset image portion(s) (24, 26, 28).

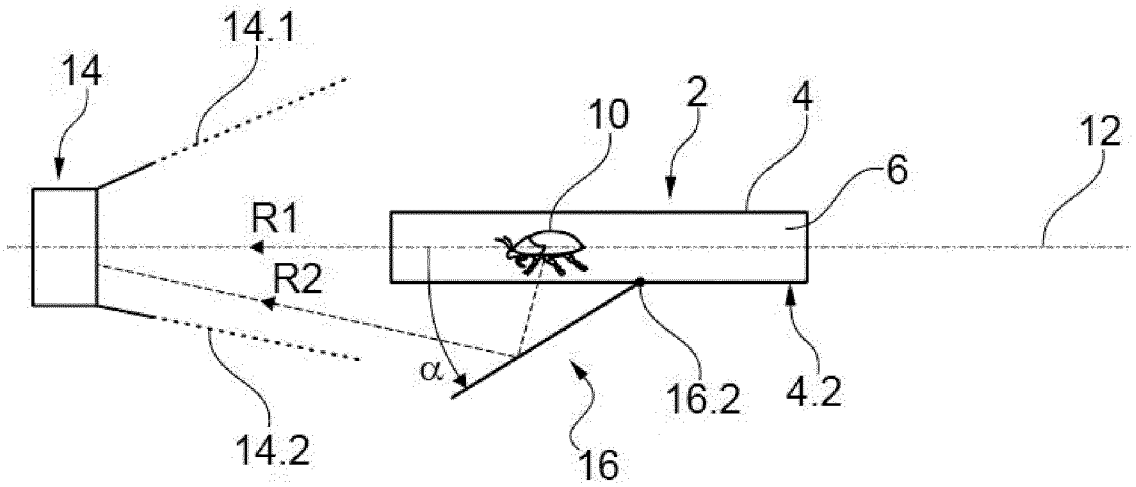
[Claim 14] Method according to any of claims 11-13, characterized in that the identification of the animal specimen (10) is performed by a computer-implemented image recognition technique optionally using a specifically trained convolutional neural network.

[Claim 15] Method according to any of claims 11-14, characterized by a step of construction of a 3D model of the animal specimens (10) based on the captured images (20) and potential extrapolations.

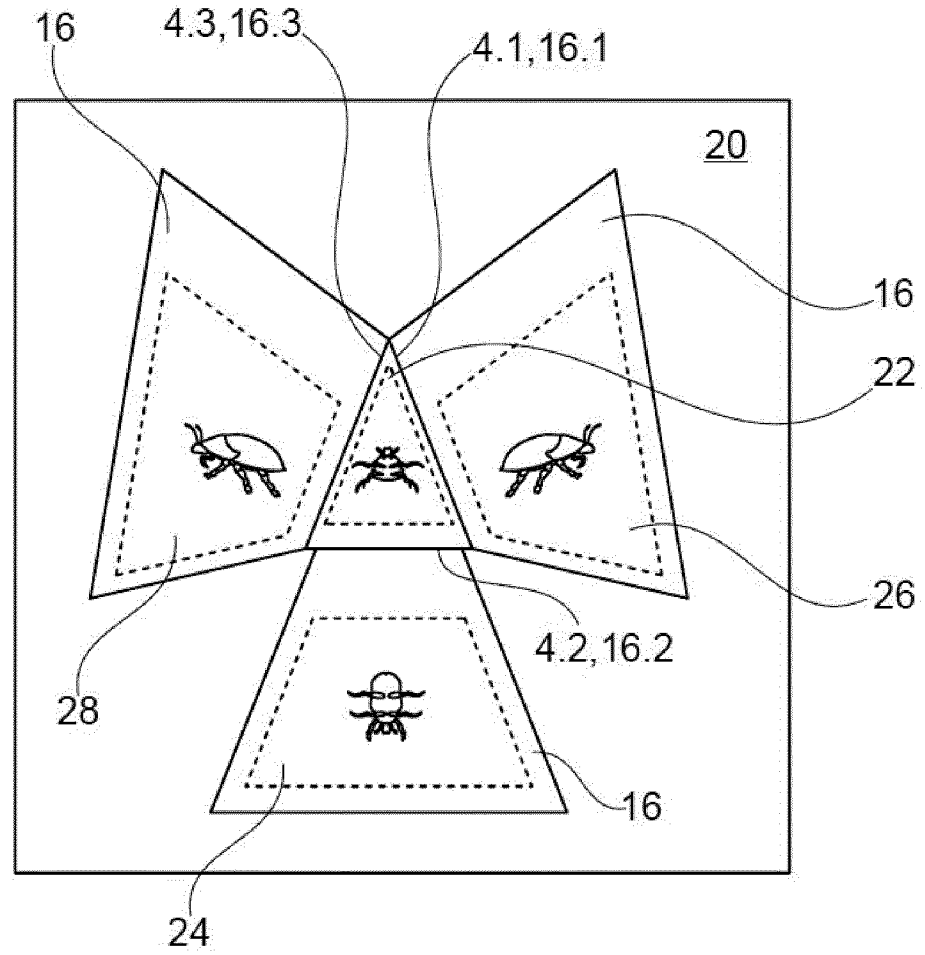
[Fig. 1]


1
2
4
18
4.3
8.2
10
4.1
12
8.1
6
R1
12
R2
4.2
16.2
14
16

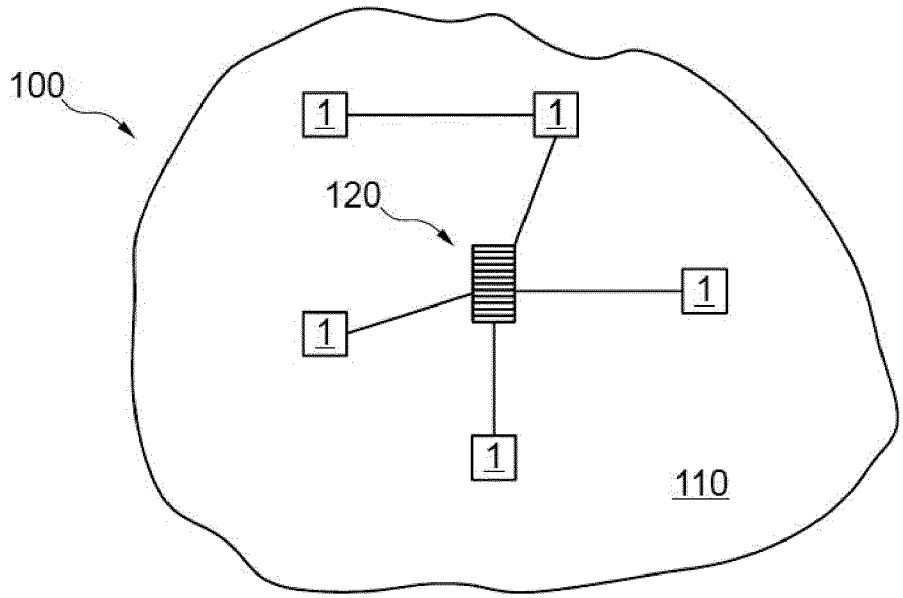
[Fig. 2]


14.1
14
10
2
4
12
6
R1
R2
α
16.2
4.2
14.2
16

[Fig. 3]



[Fig. 4]



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/087046

A. CLASSIFICATION OF SUBJECT MATTER
INV. A01M1/02 A01M31/00 A01K11/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A01M

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2014/125158 A1 (KANNIAINEN TEO [FI]) 21 August 2014 (2014-08-21) page 1, lines 6-8 page 5, line 21 - page 7, line 24 page 13, line 32 - page 17, line 16 page 19, lines 4-20 page 22, lines 12-31 figures 1, 2, 3, 4a-4c, 6a-6d, 10a, 10b	1-15
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[x] Further documents are listed in the continuation of Box C.

[x] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 March 2024	15/04/2024

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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