

TITLE OF INVENTION: SMART CAGE MODULE AND CAGE MANAGEMENT SYSTEM

FIELD

[0001] The present invention relates to a smart cage module and cage management system for managing the capture of animals such as, but not limited to, boars, civet cats and monitor lizards.

BACKGROUND

[0002] The following discussion of the background to the invention is intended to facilitate an understanding of the present invention only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was published, known or part of the common general knowledge of the person skilled in the art in any jurisdiction as at the priority date of the invention.

[0003] Wildlife can intrude into areas where their presence is not desired. These areas can include airports, forests, cities and agricultural land. There is now a community expectation that such wildlife be humanely captured and relocated to other areas, rather than simply be killed. Therefore, a common capturing technique is the use of a cage that allows for the entry of an animal while preventing escape once within the cage. However, such cages need to be regularly inspected to ensure that any trapped animal is not held within the trap for an extended period of time which could result in further suffering or death of the animal. Manpower limitations can however make it difficult or not possible to conduct regular inspections of such cages, particularly when there are a large number of cages distributed over a wide geographical area.

[0004] An object of the invention is to ameliorate one or more of the above-mentioned difficulties.

SUMMARY

[0005] According to an aspect of the present disclosure, there is provided a smart cage module for a cage trap comprising;

a microprocessor-based control unit;

at least one sensor for sensing a parameter associated with the cage trap and providing data relating to that parameter to the control unit;

at least one actuator controlled by the control unit for mechanically actuating a component of the cage trap; and

a communication module for allowing data transmission from the control unit to a cloud-based smart cage application, and for allowing control signals from the smart cage application to be received by the control unit.

[0006] In some embodiments, the cage trap parameter comprises data associated with an animal within the cage trap.

[0007] In some embodiments, the cage trap parameter comprises data associated with the open and/or closed status of a gate of the cage trap.

[0008] In some embodiments, the sensor comprises an imaging unit for viewing an interior and/or surrounding area of the cage trap.

[0009] In some embodiments, the sensor comprises a motion detection device for detecting motion within and/or surrounding the cage trap.

[0010] In some embodiments, the sensor comprises a magnetic sensor for sensing closure of a gate of the cage trap.

[0011] In some embodiments, the actuator comprises a linear actuator for activating closure and/or opening of the cage trap gate.

[0012] In some embodiments, the actuator activates a food and/or water dispenser within the cage trap.

[0013] In some embodiments, the actuator actuates a deterrent device for deterring unwanted animals from the cage trap.

[0014] In some embodiments, the smart cage module further comprises a global navigation satellite system (GNSS) for tracking a geolocation of the smart cage module.

[0015] In some embodiments, the smart cage module further comprises a beacon alert light.

[0016] According to another aspect of the present disclosure, there is provided a smart cage management system comprising:

a cloud-based web server for communicating with a plurality of smart cage modules respectively mounted on an associated cage trap, each smart cage module comprising a microprocessor based control unit, at least one sensor for sensing a parameter associated with the cage trap and providing data relating to that parameter to the control unit, at least one actuator controlled by the control unit for mechanically actuating a component of the cage; and a communication module for allowing data transmission from the control unit to a cloud-based smart cage application, and for allowing control signals from the smart cage application to be received by the control unit; and

a cloud-based web server for receiving and storing data from each smart cage module;

wherein the smart cage application is accessible from a compatible end user module for displaying the collected data and for allowing the monitoring and control of each said smart cage module.

[0017] According to another aspect of the present disclosure, there is provided a method of managing a plurality of cage traps comprising:

receiving data from a plurality of smart cage modules, each module being installed on an associated cage trap and comprising a microprocessor based control unit, at least one sensor for sensing a parameter associated with the cage trap and providing data relating to that parameter to the control unit, at least one actuator controlled by

the control unit for mechanically actuating a component of the cage; and a communication module for allowing data transmission from the control unit to a cloud-based smart cage application, and for allowing control signals from the smart cage application to be received by the control unit; and

providing control signals to a said smart cage module to thereby control a parameter of the associated cage trap.

[0018] Other aspects and features will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] In the figures, which illustrate, by way of example only, embodiments of the present invention,

[0020] Figure 1 is a schematic view showing the general architecture of the cage management system according to the present disclosure;

[0021] Figure 2 is a block diagram showing key components of a smart cage module according to the present disclosure;

[0022] Figure 3 is a schematic diagram showing the smart cage module of Fig. 2 mounted within a cage trap;

[0023] Figure 4 is a block diagram showing the data transmission from the smart cage module to the end user device; and

[0024] Figures 5a and 5b are images of the graphical user interface of the smart management system.

DETAILED DESCRIPTION

[0025] Throughout this document, unless otherwise indicated to the contrary, the terms “comprising”, “consisting of”, “having” and the like, are to be construed as non-exhaustive, or in other words, as meaning “including, but not limited to”.

[0026] Furthermore, throughout the specification, unless the context requires otherwise, the word “include” or variations such as “includes” or “including” will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

[0027] Referring initially to Fig. 1, there is shown the general architecture of the smart cage module and cage management system according to the present disclosure. The cage management system has two parts, the first being a smart cage module 1 that can be installed on a cage trap, the second part being a smart cage application 3 that is accessible to end users for managing the smart cage module 1. A plurality of cage traps can be managed, with each cage trap supporting an associated smart cage module 1. The smart cage application 3 may be hosted on the cloud 2, and accessible by end users using devices 5 such as a computer or mobile phone in an Internet of Things (IOT) configuration. The smart cage application 3 allows end users to receive data from each smart cage module 7, and to control the operation of each smart cage module 1. Each smart cage module 1 may preferably include a waterproof box within which can be located a microprocessor-based control unit 9, a mobile communication unit 7 for allowing communication between the control unit 9 and the smart cage application 3, a powered source 13 and other necessary circuitry to support interfacing to modular sensors 17 and actuators 15 of the smart cage module 1. The microprocessor-based control unit 9 may for example be in the form of a single board computer (SBC) such as a Raspberry Pi. One or more relays may also be provided within the waterproof box depending on the features of the cage trap that need to be controlled by the control unit 9. For example, the relays may control a trigger mechanism for triggering the closing of the access gate to the cage, or may control a beacon alert light for the cage trap. The sensors 17 for sensing parameters associated with the cage trap may for example consist of an imaging unit (e.g., night vision camera), a PIR (passive infrared) for motion detection, a microphone for audio input, a magnetic sensor to sense the closure of the cage gate, as well as a GNSS (Global Navigation Satellite

Systems) to track the geolocation. The actuators 15 may for example consist of a linear actuator used to activate gate closure, a beacon siren warning light and a deterrence system. Other parameters that could be sensed by sensors 17 include the temperature and/or humidity of the air surrounding the cage trap. These can for example be controlled by a cooling fan and/or deployable shade installed on the cage trap. The control unit 9 may also be equipped with wireless connectivities such as Wi-Fi and Bluetooth where other external devices (e.g., Wi-Fi camera, Bluetooth based remote trigger) can be easily integrated. Correspondingly, a number of waterproof connectors may be fitted to the exterior of the box depending on what modules are being added, for example. a connector for triggering the trap's cage opening and closing mechanism, or for activating an external food dispenser within the cage. The mobile communication unit 7 allows the module to be connected to the cloud via data communication, for example using 3G/4G/5G (when available). The module is powered by a battery 13 that can be swapped or recharged via an external solar panel for prolonged operation.

[0028] As previously noted, the smart cage application 3 is hosted on the cloud 2 and can be access using any compatible end user device 5 (e.g., mobile and laptop). The smart cage application 3 communicates with the smart cage modules 1 through web servers hosted on the cloud 2. The features on the smart cage application 3 includes but is not limited to monitoring the status of each smart cage module 1, viewing of live image or video transmitted from each of the smart cage modules 1, receiving animal alert notification from smart cage modules 1, triggering cage closure notifications from each smart cage module 1, triggering a food dispenser within the cage trap, and generating an audit trail and report for each of the smart cage modules 1. A smart cage database 8 may be created and hosted on the cloud to manage the user accounts for each end user, allow for data and image storage, as well as allowing for the logging of audit trails. For administrative users given higher control access, they can also perform administrative functions such as the adding of users, the adding/removing/grouping of the smart cage modules 1 as well as accessing the logs from the database 8.

[0029] Fig. 2 shows more details of the key components of an example embodiment of the smart cage module 1. The smart cage module 1 includes the

microprocessor-based control unit 9. That control unit 9 receives inputs of data from a number of different sensors 17. These sensors 17 can include an imaging device such as a night vision camera 19 for allowing the interior of the cage trap, and in particular the cage entrance to be remotely viewed. The imaging device 19 may also allow the area immediately surrounding the cage trap to be viewed. The sensors 17 can also or alternatively include a PIR sensor 21 for detecting any motion within and/or immediately surrounding the cage trap. Any motion detected by the PIR sensor 21 may activate the camera 19 and issue an alert so that the end user can visually confirm if the PIR sensor 21 was activated by an animal within the cage trap. It is also envisaged that a magnetic sensor 23 be used to determine whether the gate of the cage trap has been actuated and is now closed. The control unit 9 can provide output signals to, for example, control a linear actuator 25 for controlling the closure of the cage gate. The control unit 19 can also control a light source 27 for illuminating the interior of the cage trap, and possibly also the area immediately surrounding the cage trap. The smart cage module 1 may be powered by a rechargeable battery (e.g., 6V battery) which can be recharged on a daily basis by a solar panel 31.

[0030] Fig. 3 shows a schematic drawing of a cage trap 33 having a cage gate 35 within which is installed a smart cage module 1 according to the present disclosure. That module 1 comprises a waterproof box 37 within which is accommodated the control unit 9 and associated circuitry. The smart cage module 1 can be secured to the cage trap 33 using fasteners such as, for example, cable ties 39. On the exterior of the box 37 is mounted a camera 19 and/or PIR sensor 21 having a sensor field of view 41 covering the cage entrance 40. A magnetic sensor 23 is also mounted on the exterior of the box 37 facing the cage entrance 40, and is used to detect the magnetic field of a magnet 43 fixed to the cage gate 35, for example, on the handle 45 of the cage gate 35. The closure of the cage gate 35 results in the magnet 43 moving away from the magnetic sensor 23 such that it is no longer able to detect the magnetic field of the magnet 43. This loss of a detectable magnetic field will then indicate that the cage gate 35 has been closed. The cage gate 25 is closed by means of a linear actuator 25 mounted on the exterior of the box 37. The linear actuator 25 is connected via an actuation line 47, for example a string or cord to a hook member 49. The actuation line 47 is fastened to one end of the hook member 49, with the opposing end 53 of the hook member 49 being coupled to a rod member 55. The

hook member end 53 is connected to a ring 50 provided at one end of the rod member 55. The opposing end 59 of the rod member 55 is releasably coupled to the gate handle 45. Fig. 3 shows the cage gate 35 in an open position, with the rod member end 59 engaging the gate handle 45 thereby retaining the cage gate 35 in an open position. The cage gate 35 can be closed when the linear actuator 25 is actuated such that it moves linearly towards the cage gate 35. This results in the actuation line 47 pulling forward the hook member lower end 51, which in turn results in the hook member upper end 53 pulling rearwardly the rod member 55 so that it disengages the gate handle 45. This results in the closure of the cage gate 35 as the rod member 55 is released. While the described embodiment uses a linear actuator 25 to control the closure of the cage gate 35, it is also envisaged that alternative actuators such as rotary actuators, or linear/rotary solenoids be used for this purpose.

[0031] Fig. 4 shows how data from the smart cage module 1 is stored and received by each end user. Data from the sensors 17 including images from the camera 19 (step 61) can be received by the microprocessor-based control unit of the smart cage module 1 (step 62), which may be in the form of a single board computer (SBC). That data can then be transmitted through a mobile communication unit (step 63), for example a 4G module, to a cloud storage database 8 (step 65). The stored data can then be processed by a cloud hosted smart cage web application 3 (step 67) to provide the end users with the required information on the status of each cage trap to their end user device such as a laptop (step 71) or mobile phone (step 69). Multiple other smart cage modules 1 (step 72) can also similarly provide data to the cloud storage database 8 (step 65).

[0032] The smart cage web application 3 can provide information to each end user via a graphical interface 79 as shown in Figs. 5a and 5b that can be displayed on their end user device. In the example graphical interface 79, the left vertical strip 81 enables end users with administrative privileges to add and manage end users that can access the data stored within the cloud storage database, as well as adding and manging the number of smart cage modules 1 (referred to as 'devices' in the graphical interface) connected to the cloud storage database. The top right corner 87 of the graphical interface 79 shows details of the end user logged onto the smart cage application. A secure login is required for each end user, with each end user

being assigned varying levels of control. The end user can be provided with a status summary of the connected smart cage modules 1 in the top horizontal strip 83 including the number of cage traps that remain open, the number of cage traps that are closed, the number of alerts showing the detection of movement within each cage trap, and the number of modules 1 that are offline. A notification pop-up 85 is also provided near the top right corner notifying whenever the sensor of any smart cage module 1 detects movement within their associated cage trap. The main panel 89 identifies each of the smart cage modules 1 being monitored, and provide information on their location and status, and the last time that the smart cage module 1 was online. Clicking on any of the module panels will result in the opening of a specific notification panel 91 as shown in Fig. 5b. This notification panel provides more controls for the smart cage module 1. A camera image may be shown with the ability to record video or capture images of the interior of the associated cage trap. The control can include the opening or closing of the cage trap. Other details of the smart cage module 1 that may be provided include the charge remaining in the battery 29 of the smart cage module 1, the date and time when the cage trap was last attended to, details of the person who attended the cage trap, the signal strength of the communication module, and the GPS location of the smart cage module 1 and the associated cage trap.

[0033] The method of display of the graphical interface 79 of the smart cage application 3 allows for easy monitoring of multiple cage traps across many sites, making it much more efficient to manage cage traps over a large area, with a reduced need for manpower.

[0034] Viewing of the information provided by the smart cage application 3 may also be selective and tightly controlled with a login system. Different users may be granted varying levels of access to the data depending on their needs. This also allows the smart cage management system according to the present disclosure to help a single company to cater to multiple clients and stakeholders using the same platform.

[0035] Manual access to the information collected by a smart cage module 1 will also preferably not be possible. Data from the camera will be transmitted to the cloud

storage database 8, and will not be stored on site. In other words, someone who manages to get access to the smart cage module 1 of a cage trap will not be able to obtain any sensitive data from the module 1.

[0036] It is also envisaged that the smart cage module 1 may include an option to include a deterrence device, which may for example fire pellets or emit sound to deter unwanted target species or individual animals which the user does not want to trap.

The smart cage module 1 according to the present disclosure may also be modular in nature. Different modules, that can be controlled by the smart cage module 1 ;can be added or removed depending on the needs of each client. This would be able to reduce the costs per unit, or increase the capability of the unit as required. Such modules could include the following:

- a) A food dispenser to provide food for the trapped animal;
- b) a deterrence device for deterring unwanted animals away from the cage trap;
- c) an audio recorder for recording sound within and surrounding the cage trap;
- d) a cooling fan to help regulate temperature within the cage; and
- e) a deployable shade for covering the cage trap to both regulate temperature and reduce stress to the animal.

[0037] It is also envisaged that the smart cage module 1 may be attached to popular existing cage traps, transforming them into “smart cages”. As the smart cage module 1 may be modular, different open/close mechanisms can be added or removed depending on the cage which is used.

[0038] Throughout the description, it is to be appreciated that the term ‘processor’ and its plural form include microcontrollers, microprocessors, programmable integrated circuit chips such as application specific integrated circuit chip (ASIC), computer servers, electronic devices, and/or combination thereof capable of processing one or more input electronic signals to produce one or more output electronic signals. The processor includes one or more input modules and one or more output modules for processing of electronic signals.

[0039] Throughout the description, it is to be appreciated that the term 'server' and its plural form can include local, distributed servers, and combinations of both local and distributed servers.

[0040] Throughout the description, it is to be appreciated that the term 'channel' or 'channels' include wired or wireless electronic communication channels. The wireless electronic communication channels may include, but is not limited to, Wi-Fi, Bluetooth, Bluetooth LE, GPRS (General Packet Radio Service), Enhanced Data GSM Evolution (EDGE) etc.

[0041] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as is commonly understood by a skilled person to which the subject matter herein belongs.

[0042] It should be appreciated by the person skilled in the art that the above invention is not limited to the embodiment described. It is appreciable that modifications and improvements may be made without departing from the scope of the present invention.

[0043] It should be further appreciated by the person skilled in the art that one or more of the above modifications or improvements, not being mutually exclusive, may be further combined to form yet further embodiments of the present invention.

CLAIMS

[Claim 1]. A smart cage module for a cage trap comprising;

a microprocessor-based control unit;

at least one sensor for sensing a parameter associated with the cage trap and providing data relating to that parameter to the control unit;

at least one actuator controlled by the control unit for mechanically actuating a component of the cage trap; and

a communication module for allowing data transmission from the control unit to a cloud-based smart cage application, and for allowing control signals from the smart cage application to be received by the control unit,

wherein the at least one sensor comprises a motion detection device for detecting motion within and/or surrounding the cage trap,

wherein the at least one sensor comprises an imaging unit for viewing an interior and/or surrounding area of the cage trap,

wherein the imaging unit can be activated when the motion detection device detects said motion within the cage trap to visually determine if an animal is trapped therein, and

wherein the at least one actuator can activate a food and/or water dispenser within the cage trap when the animal is determined to be trapped therein.

[Claim 2]. A smart cage module according to claim 1, wherein the cage trap parameter comprises data associated with an animal within the cage trap.

[Claim 3]. A smart cage module according to claim 1 or 2, wherein the cage trap parameter comprises data associated with the open and/or closed status of a gate of the cage trap.

[Claim 4]. A smart cage module according to any one of the preceding claims, wherein the at least one sensor comprises a magnetic sensor for sensing closure of a gate of the cage trap

[Claim 5]. A smart cage module according to any one of the preceding claims, wherein the at least one actuator comprises a linear actuator for activating closure and/or opening of the cage trap gate.

[Claim 6]. A smart cage module according to any one of the preceding claims, wherein the smart cage module further comprises a global navigation satellite system (GNSS) for tracking a geolocation of the smart cage module.

[Claim 7]. A smart cage module according to any one of the preceding claims, wherein the smart cage module further comprises a beacon alert light.

[Claim 8]. A smart cage management system comprising:

a cloud-based web server for communicating with a plurality of smart cage modules respectively mounted on an associated cage trap, each smart cage module comprising a microprocessor based control unit, at least one sensor for sensing a parameter associated with the cage trap and providing data relating to that parameter to the control unit, at least one actuator controlled by the control unit for mechanically actuating a component of the cage; and a communication module for allowing data transmission from the control unit to a cloud-based smart cage application, and for allowing control signals from the smart cage application to be received by the control unit; and

a cloud-base web server for receiving and storing data from each smart cage module;

wherein the smart cage application is accessible from a compatible end user module for displaying the collected data and for allowing the monitoring and control of each said smart cage module;

wherein the at least one sensor comprises a motion detection device for detecting motion within and/or surrounding the cage trap,

wherein the at least one sensor comprises an imaging unit for viewing an interior and/or surrounding area of the cage trap,

wherein the imaging unit can be activated when the motion detection device detects said motion to visually determine if an animal is trapped within the cage trap, and

wherein the at least one actuator can activate a food and/or water dispenser within the cage trap when the animal is determined to be trapped therein.

[Claim 9]. A smart cage management system according to claim 8, wherein the cage trap parameter comprises data associated with an animal within the cage trap.

[Claim 10]. A smart cage management system according to claim 8 or 9, wherein the cage trap parameter comprises data associated with the open and/or closed status of a gate of the cage trap.

[Claim 11]. A smart cage management system according to any one of claims 8 to 10, wherein the cage module is controlled to allow for the opening or closing of a gate of the cage trap.

[Claim 12]. A method of managing a plurality of cage traps comprising:

receiving data from a plurality of smart cage modules, each module being installed on an associated cage trap and comprising a microprocessor based control unit, at least one sensor for sensing a parameter associated with the cage trap and providing data relating to that parameter to the control unit, at least one actuator controlled by the control unit for mechanically actuating a component of the cage; and a communication module for allowing data transmission from the control unit to a cloud-based smart cage application, and for allowing control signals from the smart cage application to be received by the control unit; and

providing control signals to a said smart cage module to thereby control a component of the associated cage trap,

wherein the at least one sensor comprises a motion detection device for detecting motion within and/or surrounding the cage trap,

wherein the at least one sensor comprises an imaging unit for viewing an interior and/or surrounding area of the cage trap,

wherein the imaging unit can be activated when the motion detection device detects said motion to visually determine if an animal is trapped within the cage trap, and

wherein the at least one actuator can activate a food and/or water dispenser within the cage trap when the animal is determined to be trapped therein.

[Claim 13]. A method of managing a plurality of cage traps according to claim 12, wherein the cage trap parameter comprises data associated with an animal within the cage trap.

[Claim 14]. A method of managing a plurality of cage traps according to claim 12 or 13, wherein the cage trap parameter comprises data associated with the open and/or closed status of a gate of the cage trap.

[Claim 15]. A method of managing a plurality of cage traps according to any one of claims 12 to 14, wherein the smart cage module is controlled to allow for the opening or closing of a gate of the cage trap.