SMART INSECT TRAP

TECHNICAL FIELD

[0001] The present disclosure relates to a smart insect trap, and in particular to an insect trap that traps and kills predetermined kinds of insects.

BACKGROUND

[0002] Insect pests such as mosquitoes, flies and moths can transmit diseases and destroy property. To exterminate them, poisonous sprays and traps have been deployed, but such extermination means often also indiscriminately destroy other beneficial insects such as ladybirds that control other insect pests and bees that have an important role in plant pollination. It is therefore desirable to provide an insect trap that can trap and kill only predetermined kinds of insects without harming others.

SUMMARY

[0003] According to a first aspect, there is provided a smart insect trap comprising: a sensing portion having a through opening and an assembly of sensors configured to capture a signature of signals that are generated consequent to passage of an insect through the through opening, wherein the signature of signals is used by a processor of the sensing portion to identify at least one of: a type, a species, a subspecies, and a sex of the insect; a trapping portion in fluid communication with the through opening, the trapping portion comprising a container configured to hold water therein and a number of killing mechanisms provided to kill insects in the container; a controller in communication with the processor and configured to activate the number of killing mechanisms in response to identification by the sensing portion of at least one of: a predetermined type, a predetermined species, a predetermined subspecies and a predetermined sex of the insect; a water refilling mechanism for refilling water in the container, the water refilling mechanism comprising a water storage tank provided in fluid communication with the container, wherein the water storage tank is activatable by the controller to release water into the container upon detection of the water level in the container being below the predetermined water level by a water level sensor.

[0004] The number of killing mechanisms may include an electrifiable netting provided across the container above the predetermined water level to electrocute insects that come into contact with the electrifiable netting when the electrifiable netting is activated by the controller.

[0005] The number of killing mechanisms may include an ultrasonic transducer provided in the container below the predetermined water level to generate ultrasonic waves configured to kill insects in the water when the ultrasonic transducer is activated by the controller.

[0006] The number of killing mechanisms may include a rotatable blade configured to kill insects in the water when the rotatable blade is activated by the controller.

[0007] The smart insect trap may further include a netted portion provided across an opening provided at a bottom of the container, the netted portion configured to allow passage of water and to prevent passage of insects therethrough, and the smart insect trap may further include a valve provided in the opening at the bottom of the container, wherein the controller is programmed to open the valve periodically to drain water from the container and retain insects in the netted portion to be killed by dehydration over time in the netted portion.

[0008] The killing mechanisms may be provided in a first portion of the container and the water storage tank may be provided in fluid communication with a second portion of the container, wherein the first portion and the second portion are separated by a screen configured to allow passage of water therethrough and to prevent passage of insects therethrough.

[0009] According to a second aspect, there is provided a smart insect trapping system comprising: a number of the smart insect traps according to any one of claims 1 to 6; and a main server with which the processor of the sensing portion of each smart insect trap is communicatively connected via the Internet, wherein information obtained by the processor of each smart insect trap is transmitted to the main server for processing and wherein results obtained from the processing can be downloaded for viewing by clients of the main server.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] In order that the invention may be fully understood and readily put into practical effect there shall now be described by way of non-limitative example only exemplary embodiments of the present invention, the description being with reference to the accompanying illustrative drawings.

FIG. 1A is a schematic illustration of an exemplary embodiment of a smart insect trap.

FIG. 1B is a schematic illustration of an exemplary bottom opening and valve of the insect trap of FIG. 1A.

FIG. 1C is a schematic illustration of an exemplary embodiment of a water filling mechanism of an alternative embodiment of the insect trap.

FIG. 2 is a block diagram of an insect trapping system comprising a number of the insect traps.

FIG. 3 is a block diagram of circuitry provided to perform processes by a processor of a sensing portion of the insect trap.

FIG. 4 is a cross sectional view of the sensing portion.

FIG. 5A is a front side view of a first embodiment of a sensor of the sensing portion.

FIG. 5B is a top side view of the first embodiment of the sensor.

FIG. 6A is a front side view of a second embodiment of the sensor.

FIG. 6B is a top side view of the second embodiment of the sensor.

FIG. 7A is a front side view of a third embodiment of the sensor.

FIG. 7B is a top side view of the third embodiment of the sensor.

FIG. 8A is a front side view of a fourth embodiment of the sensor.

FIG. 8B is a top side view of the fourth embodiment of the sensor.

FIG. 9A is a right side view of the second embodiment of the sensor.

FIG. 9B is a right side view of an alternative of the second embodiment of the sensor.

FIG. 10 is a right side view of the third embodiment of the sensor.

FIG. 11A is a right side view of the fourth embodiment of the sensor.

FIG. 11B is a right side view of an alternative of the fourth embodiment of the sensor.

FIG. 12 is a flow diagram of a process performed by the processor to detect and identify an insect.

DETAILED DESCRIPTION

[0011] Exemplary embodiments of the smart insect trap 100 will be described with reference to FIGS. 1 to 12 in which the same reference numerals are used across the FIGS. to refer to the same or similar parts.

[0012] In an exemplary embodiment as shown in FIG. 1A, the smart insect trap 100 generally comprises a sensing portion 110, a trapping portion 125 provided to trap and kill insects that have entered the smart insect trap 100, a water refilling mechanism 150. A power source (not shown) is provided to power the various components of the smart insect trap 100. The power source may be battery operated or direct fed from a power grid. An external energy charging source can be incorporated such as a solar panel to extend the operational time of the smart

insect trap 100. This is necessary for deployments in far locations where it is not possible to have routine inspections or maintenance and where it is not possible to draw power from the power grid.

[0013] The sensing portion 110 has a through opening 111 and an assembly of sensors 120 configured to capture a signature of signals generated by passage of an insect through the through opening 111. The signals are used by a processor 200 of the sensing portion 120 (shown in FIG. 4) to identify at least one of: a type, a species, a subspecies, and a sex of the insect. The sensing portion 110 will be described in greater detail below.

[0014] The trapping portion 125 comprises a container 126 configured to hold water 127 at a predetermined water level 128 therein. The container 126 is in fluid communication with the through opening 111 of the sensing portion 110 so that insects that pass through the through opening 110 enter the container 126. In exemplary embodiments, the sensing portion 110 is provided on top of the trapping portion 125 as shown in FIGS. 1A and 4.

[0015] The trapping portion 125 further comprises a number of killing mechanisms 130 provided to kill insects in the container 126, as shown in FIG. 1A. Each of the killing mechanisms 130 is separately activatable by a controller (not shown) that is in communication with the processor 200, in response to identification of at least one of: a predetermined type, a predetermined species, a predetermined subspecies and a predetermined sex of the insect by the sensing portion 120.

[0016] In an exemplary embodiment, the killing mechanisms 130 include an electrifiable netting 131 provided across the container 126 above the predetermined water level. The electrifiable netting 131 electrocutes insects that come into contact with the electrifiable netting 131 when the electrifiable netting 131 is activated or turned on by the controller. The killing mechanisms 130 may further include an ultrasonic transducer 132 provided in the container 126 below the predetermined water level to generate ultrasonic waves configured to kill insects in the water 127 when the ultrasonic transducer 132 is activated or turned on by the controller. The killing mechanisms 130 may yet further include a rotatable blade 133 configured to kill insects in the water 127 when the rotatable blade 133 is activated or turned on by the controller.

[0017] An opening 129 closed by a valve 135 may be provided at a bottom of the container 126 for draining of the water 127 in the container 126, as shown in FIG. 1B. The valve 135 may comprise a bi-leaflet valve 135A or a tilting valve 135B, for example. The controller may

be programmed to open the valve 129 periodically to drain the container 126. A netted portion 134 may be provided across the opening 129. The netted portion 134 is configured to allow passage of water therethrough and to prevent passage of insects therethrough, so that any insects retained in the netted portion 134 upon drainage of the container 126 are killed by dehydration over time in the netted portion 134. The netted portion 134 may comprise a mesh bag or filter, for example.

[0018] In general, the water refilling mechanism 150 of the smart insect trap 100 comprises a water storage tank 152 provided in fluid communication with the container 126 for refilling water in the trapping portion 125. This allows the smart insect trap 100 to be deployed for an extended period of time (for example three months or six months) without requiring human attendance to top up the water 127 in the container 126. In a first exemplary embodiment of the water filling mechanism 150 as shown in FIG. 1A, the killing mechanisms 130 are provided in a first portion 126-1 of the container 126 while the water storage tank 152 is provided in fluid communication with a second portion 126-2 of the container 126. The first portion 126-1 and the second portion 126-2 are preferably horizontally adjacent to each other and separated by a screen 153 configured to allow passage of water therethrough and to prevent passage of insects therethrough. The screen 153 may comprise a filter or a net, for example. Water level in the first portion 126-1 corresponds with water level in the second portion 126-2 as the two portions are in fluid communication with each other across the screen 153. The water storage tank 152 is activatable by the controller to release water into the second portion 126-2 upon detection of the water level 128 in the container 126 being below the predetermined water level 128 by a water level sensor (not shown) provided in the container 126.

[0019] In a second exemplary embodiment of the water filling mechanism 120 as shown in FIG. 1C, water in the water storage tank 152 is directly pumped into the container 126 periodically. Openings 126 may be provided at a predetermined height from the top of the container 126 to allow excess water to overflow out of the container 126.

[0020] FIG. 2 shows an exemplary embodiment of a smart insect trapping system 101 comprising a number of the smart insect traps 100. The sensing portion 110 of each smart insect trap 100 is provided with a processor 200 in communication with the controller of the smart insect trap 100. The processor 200 is configured to allow the smart insect trap 100 to be communicatively connected to a main server 140 via the internet 142. Information obtained by the processor 200 of each smart insect trap 100 may be transmitted to the main server 140 for

final processing. The analysis results from the processing performed by the main server can then be downloaded by various devices 170 such as tablets or mobile phones for viewing.

[0021] The main server 140 may be a typical processing system such as desktop computer, laptop computer, or other computer terminal that is connected to internet 142 via either a wired or wireless connection to transmit information to and receive information from the processor 200 of the sensing portion 110. The main server 140 executes applications that perform the required processes in accordance with this disclosure. One skilled in the art will recognize that although only one main server 140 is shown, any number of servers may be connected and/or operating in parallel to perform the applications for providing embodiments of this disclosure without departing from this disclosure.

[0022] Processes are stored as instructions in a media that are executed by a processing unit of the main server 140 or a virtual machine running on the main server 140 to provide the method and/or system in accordance with this disclosure. The instructions may be stored as firmware, hardware, or software.

[0023] When an insect passes through the through opening 111, signals are acquired from a detector of the sensing portion 110 and deconstructed to extract information such as the type, size, sex, species, and subspecies of an insect that has entered the smart insect trap 100. The deconstruction algorithm can be based on a Fourier transform, neural-network or wavelets where some form of pattern recognition algorithm can be applied to identify features in the signals. This algorithm can be implemented directly by the processor 200 of the sensing portion 110, or transmitted to the main server 140 to be centrally processed.

[0024] The sensing portion 110 comprises an assembly of sensors installed in a manner that is triggered when an insect enters the sensing portion 110. The sensing portion 110 then captures the signature of signals generated by the flight of the insect and sends the information to the processor 200. In a first exemplary embodiment, the processor 200 may transmit the information to the main server 140. A software application that includes an identification algorithm and a database of signatures unique to different species of insect such as mosquitoes may be provided in the processing unit of the main server 140. The signatures are also unique to the genders of each species of insects. The identification algorithm includes an artificial intelligence (AI) to identify the insect generating the signature of signals. Alternatively, the application including the identification algorithm and the database of signatures unique to

different species of insect such as insects may be provided in the processor 200 of the sensing portion 110.

[0025] FIG. 3 illustrates the block diagram of the processor 200 of the sensing portion 110. The processor 200 can receive and transmit data, execute software applications. The processor 200 comprises a processor 310, memory 320, transceiver 330, and input/output ports 340.

[0026] The processor 310 is a processor, microprocessor, microcontroller, application specific integrated circuit, digital signal processor (DSP), programmable logic circuit, or other data processing device that executes instructions to perform the processes in accordance with the present invention. The processor 310 has the capability to execute various applications that are stored in the memory 320.

[0027] The memory 320 may include read-only memory (ROM), random-access memory (RAM), electrically erasable programmable ROM (EEPROM), flash cards, or any memory commonly used for computers. The memory 320 stores instructions which are executable by the processor 310 to perform processes in accordance with the method and system of this disclosure. The memory 320 has sufficient capacity where data can be stored on the processing unit when it cannot be sent out to the main server 140 or as backup until a user is able to manually download the information.

[0028] Transceiver 330 connects processor 310 to a network for transmission of data to and from other processing systems such as main server 140. Transceiver 330 has long range wireless communication capability such as 3G/4G/5G telecommunication network protocols and/or short and/or medium range wireless capability such as Wireless Fidelity (Wi-Fi), Bluetooth, infrared, Zigbee, etc.

[0029] One or more input/output (I/O) ports 340 can be configured to allow the processor 310 to communicate with and control from various I/O devices. Peripheral devices that may be connected to processor 200 via the I/O ports 340 include the sensing portion 110, a display, keypad, a USB storage device, an SD card or other storage device for transmitting information to or receiving information from the processor 200. In addition to updating applications stored on memory 320 or installing new applications onto the memory via the network device 330, a user may alternatively install new applications or update applications on the memory 320 through a user interface such as a USB via the I/O ports 340. Additional environment sensors

430 can be incorporated such as temperature and humidity sensors which data can be similarly stored or transmitted to the main server 140. Each of the individual components such as the sensing portion 110, environment sensors 430 are identified and data time-logged.

[0030] One skilled in the art will recognize that other features may be included in the processor 200. Further, the components in processor 200 may be replaced by other components that perform similar functions. In brief, the processor 200 as shown in FIG. 3 is considered merely illustrative and non-limiting.

[0031] In order to reduce the cost of having to furnish each transceiver 330 with 3G/4G communication capability, the transceiver 330 may be equipped with short and/or medium range wireless capability and wirelessly connects to a sub-server. The sub-server would subsequently transmit the information to the main server 140. Essentially, the sub-server reduces the cost of having to furnish each processor 200 with 3G/4G communication capability. If future network communication protocol includes Internet of Things (IoT) communication at a more cost-efficient rate, the processor 200 may be configured to transmit the information directly to the main server 140. In one embodiment, the transceiver 330 enables real-time upload of data to the main server 140 for further processing.

[0032] As mentioned, the sensing portion 110 comprises an assembly of sensors 120 configured to detect an insect entering the smart insect trap 100. The assembly of sensors 120 capture a signature of signals generated by movement of the insect in the through opening 111, such as the flight pattern of the insect. The signatures are collected by the processor 200. The assembly of sensors 120 are arranged in a manner that is able to capture a signature that accurately counts the number of insects, as well as determine the species, subspecies and gender of the insect when the insects enter the smart insect trap 100.

[0033] As it is not possible to predict when an insect enters the smart insect trap 100, the sensing portion 110 has to be in an “always-on” state. At the same time, it is desirable for the sensing portion 110 to consume minimal power. Hence, the sensing portion 110 uses an optical detector as it provides a balance between low power, high accuracy and always operational. This involves using one or more optical sources that constantly emit a beam that passes through a desired area to be monitored, i.e., at least a portion of the through opening 111 of the sensing portion 110. At least one detector is provided opposite the one or more optical sources to pick up the optical signals. This detector can be a single pixel or array

detector. As an insect flies through the optical beam, the signal is modulated by the insect and the modulated beam is picked up by the detector.

[0034] FIG. 4 shows a cross-sectional view of an exemplary embodiment of the sensing portion 110 of the smart insect trap 100. In this embodiment, the sensing portion 110 comprises an assembly of sensors 120 arranged within a housing 400 and the processor 200 is provided at one side of the housing 400. While FIG. 4 shows four sensors 120 arranged one on top of the other, it will be apparent from the description below that other arrangement of the sensors 120 may be implemented without departing from the disclosure. The through opening 111 is provided in the housing 400 and allows insects 590 to enter and pass through the sensing portion 110, as shown by arrow 491. The processor 200 may be provided along a side wall of the housing for more efficient arrangement of the communication lines between the processor 200 and sensors 120. Alternatively, the processor 200 may be provided along a front wall or rear wall of the housing 400, for example.

[0035] FIG. 5A shows a front side view of a sensor 120 and FIG. 5B shows the top side view of the sensor 120. The sensor 120 comprises an optical source 510, a first lens group 520, iris 530, a second lens group 540, an optical filter 550 and an optical detector 560. The optical source 510 and optical detector 560 are arranged on opposite ends. The first lens group 520 and second lens group 540 are arranged between the optical source 510 and optical detector 560 to define a sensing zone 535. The iris 530 is arranged between the first lens group 520 and the entrance of the sensing zone 535. The optical filter 550 is arranged between the second lens group 540 and the optical detector 560.

[0036] The optical source 510 may be a laser emitter, such as a laser diode that emits a laser beam, an infrared emitter that emits an infrared beam, or any other appropriate light emitter such as a light emitting diode (LED). The optical source 510 is essentially a light emitter modulated with an external phase plate or an external shutter and operating at Visible Near Infra-Red (VIS-NIR) wavelengths.

[0037] The first lens group 520 is arranged after the optical source 510 to collimate an emitted beam from the optical source 510 and to spread coverage of the emitted beam as large as possible while not compromising on the resultant output signal strength. A collimated beam is needed to pick up high frequency but low attenuation signals from the insects which would otherwise not be detected. The exact arrangement and configuration of the lens in the first lens group 520 are omitted for brevity as this is well known in the art. More importantly, the first lens

group 520 has to receive and collimate the emitted light from the optical source such that the first lens group 520 projects an outgoing optical beam 537 with a beam width 512 of a first predetermined range and a beam height 511 of a second predetermined range. Particularly, the beam width 512 is between 10-120mm and the beam height 511 is less than 10 times the size of the insect to be detected in order to maximize the high frequency perturbations. Preferably, the beam height 511 is less than 50mm for determining insects or within 5 to 10 times the size of the insect to be detected.

[0038] It should also be noted that the first lens group 520 must be configured according to the type of the optical source 510 that will be used. This is because different types of optical source 510 emit light with different characteristics. Hence, a change in the choice of optical source 510 would likely require a reconfiguration of the first lens group 520 in order to achieve an outgoing optical beam 537 with a beam width 512 of a first predetermined range and a beam height 511 of a second predetermined range. The first lens group 520 may include a prism or mirror to fold the optics, to achieve a more compact form factor.

[0039] The optical filter 550 is arranged after the first lens group 520 and serves to filter out external sources from the environment. The iris 530 serves to allow only a uniform optical beam 537 from the first lens group 520 to pass through.

[0040] The second lens group 540 is arranged before the optical detector 560 to collect the emitted optical beam 537 from the first lens group 520. The second lens group 540 may also include at least one prism or mirror to fold the optics to reduce the size of the overall optics. In short, the second lens group 540 is arranged apart from the first lens group to define a sensing zone 535 therebetween, and is configured to collect the optical beam 537 from the first lens group 520. All lenses in the first and second lens group 520 and 540 may be made using plastic injection moulding or using glass or wafer-level optics. The collimated beam 537 configuration allows modulation by the insect in the sensing zone 535 to have a consistent signal strength throughout the optical path, without which the intensity of the modulations would vary depending on where the insect passes through the optical path.

[0041] The emitted optical beam can be modulated at the optical source or pass through a phase plate or a shutter to introduce known perturbations into the beam which is then deconstructed after detection.

[0042] The optical detector 560 is a device that converts the visible light into electrical signal. In order to maximize the efficiency of the optical detector 560, the optical detector 560 needs

to be able to operate at a frequency of about less than 10 KHz. The lower operating frequency of the optical detector 560 serves to attenuate high frequency signals from possible external influences like the environment. It is possible for a single optical detector 560 to cover a 10mm to 120mm beam width 512, thus lowering power consumption and cost of implementation.

[0043] As shown in FIG. 5A, an insect 590 flies through the sensing zone 535 which is defined within the through opening 111, in the direction shown by arrow 591, thereby passing through optical beams 537. Detection of the insect flying through the sensing zone 535 and the type of insect is based on the modulated beam received by the optical detector 560. When the insect passes through the sensing zone 535, the emitted beam from the first lens group 520 is modulated by the insect which in turn is a beam signature that is unique to the insect. In short, the modulated beam is essentially a signature of the insect.

[0044] Appreciably, the optical source 510, first lens group 520, second lens group 540, and optical detectors 560 will be enclosed along the length of the pathway of the optical beam 537 such that the optical beam 537 can leave and enter only through a restricted passage. This ensures that stray light is prevented from entering the optical source 510, first lens group 520, second lens group 540, and optical detectors 560. While FIGS. 5A and 5B do not show housings or enclosures covering the optical source 510, first lens group 520, second lens group 540, and optical detectors 560, one skilled in the art will recognise that the housings or enclosures are provided along the length of the pathway of the optical beam except the sensing zone 535.

[0045] FIGS. 6A, 6B, 7A, 7B, 8A, and 8B illustrate different embodiments on the configuration and arrangement of the sensor 120.

[0046] FIG. 6A shows a front side view of the sensor 120 having a pair of first lens group 520, second lens group 540 and optical detectors 560 and FIG. 6B shows the top side view of the sensor 120. In this configuration, the pair of first lens group 520, second lens group 540 and optical detectors 560 is arranged one on top of the other such that the pair of first lens group 520 produces two sets of optical beams 537 and the optical detectors 560 receives the two sets of optical beams 537 via the pair of second lens group 540. Further, while the pair of first lens group 520 is shown as separate pieces, one skilled in the art will recognise that the pair of first lens group 520 may be provided as a single piece first lens group 520 without departing from the disclosure. Similar to the pair of first lens group 520, the pair of second lens group 540 may be provided as a single piece second lens group 540 without departing from the

disclosure. The optical source 510, each of the first lens group 520, each of the second lens group 540, and each of the optical detectors 560 will be enclosed along the length of the pathway of the optical beam such that optical beam will only be able to leave and enter through a restricted passage. This ensures that stray light is prevented from entering the optical source 510, each of the first lens group 520, each of the second lens group 540, and each of the optical detectors 560. While FIGS. 6A and 6B do not show housings or enclosures covering the optical source 510, each of the first lens group 520, each of the second lens group 540, and each of the optical detectors 560, one skilled in the art will recognise that the housings or enclosures are provided along the length of the pathway of the optical beam except the sensing zone 535. Advantageously, in this configuration, one optical source 510, iris 530 and optical filter 550 is required, reducing the cost of materials. Furthermore, in this configuration, insects flying through will thereby pass through two sets of optical beams 537. This allows the system to identify the flight direction of the insects and also collect more information from two sets of beams for a single insect. For example, this allows a user to determine whether the insect is flying from the top to bottom of the through opening 111 or bottom to top of the through opening 111. FIG. 9A shows the configuration of the optical detector 560 and the optical filter 550 when viewed from the direction of the arrow 610. As shown in FIG. 9A, a number of sensors 120 are arranged one on top of the other within the housing 400 where each sensor 120 comprises a pair of first lens group 520, second lens group 540 and optical detectors 560. An alternative arrangement is shown in FIG. 9B where more than 2 first lens group 520, second lens group 540 and optical detectors 560 may be provided in one sensor 120.

[0047] FIG. 7A shows a front side view of a number of sensors 120 cascaded in the vertical direction and FIG. 7B shows the top side view of a number of sensors 120 cascaded in the horizontal direction forming a two-dimensional array. In this configuration, the insect flies through multiple optical beams and is applicable for situations where the flight paths of the insects need to be monitored. FIG. 10 shows the configuration of the optical detector 560 and the optical filter 550 when viewed from the direction of the arrow 710.

[0048] FIG. 8A shows a front side view of a number of sensors 120, each in the same configuration as shown in FIG. 6A which is cascaded in the vertical direction and FIG. 8B shows the top side view of a number of sensors 120 cascaded in the horizontal direction forming a two-dimensional array. In this configuration, the insects can be monitored over a larger area. A structural wall separating the individual optical beams may or may not be needed in this configuration. FIG. 11A shows the configuration of the optical detector 560 and the optical filter 550 when viewed from the direction of the arrow 810. An alternative arrangement

is shown in FIG. 11B where more than 2 first lens group 520, second lens group 540 and optical detectors 560 may be provided in one sensor 120.

[0049] FIG. 12 illustrates a flow diagram of process 1200 performed by the processor in the processor 200 in accordance with an embodiment of this disclosure. Process 1200 begins with step 1205 to activate the optical source 510 and monitor for electrical signal received from the optical detector 560. Upon receiving an electrical signal, the electrical signal is stored in the memory together with a time stamp in step 1210. After a predetermined time, all the electrical signals with time stamps are transmitted to the server in one or more data packages in step 1215. The data packages may be transmitted directly to the server via the internet or via a mobile memory storage. Process 1200 ends after step 1215.

[0050] With the above-described smart insect trap 100, the controller can be configured to activate the killing mechanisms 130 only upon detection of undesirable insects passing through the sensing portion 110. Such undesirable insects can be identified according to their type, species, subspecies and/or sex. For example, only the females of some species of mosquitoes are harmful in transmitting disease. Thus, as the smart insect trap 100 is able to specifically identify only truly harmful insects such as the females of certain species of mosquitoes, harmful flies and destructive moths, it allows such undesirable insects to be detected and killed, while allowing harmless or even beneficial insects such as ladybirds and bees to pass in and out of the smart insect trap 100 unharmed. The smart insect trapping system 101 further allows undesirable insects to be exterminated at many locations within a large area as a form of pest control, by allowing multiple units of the smart insect trap 100 that have been deployed to be remotely and conveniently monitored using different devices including handheld ones.

[0051] While there has been described in the foregoing description exemplary embodiments of the present invention, it will be understood by those skilled in the technology concerned that many variations in details of design, construction and/or operation may be made without departing from the present invention. It will be appreciated that many further alterations, modifications and permutations of various aspects of the described embodiments are possible that fall within the spirit and scope of the appended claims.

[0052] Throughout this specification and the claims which follow, unless the context requires otherwise, the word “comprise”, and variations such as “comprises” or “comprising”, will be understood to imply the inclusion of a stated integer or group of integers or steps but not the exclusion of any other integer or group of integers.

[0053] The reference in this specification to any matter which is known is not and should not be taken as an acknowledgment or admission or any form of suggestion that that known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

CLAIMS

1. A smart insect trap comprising:

a sensing portion having a through opening and an assembly of sensors configured to capture a signature of signals that are generated consequent to passage of an insect through the through opening, wherein the signature of signals is used by a processor of the sensing portion to identify at least one of: a type, a species, a subspecies, and a sex of the insect;

a trapping portion in fluid communication with the through opening, the trapping portion comprising a container configured to hold water therein and a number of killing mechanisms provided to kill insects in the container;

a controller in communication with the processor and configured to activate the number of killing mechanisms in response to identification by the sensing portion of at least one of: a predetermined type, a predetermined species, a predetermined subspecies and a predetermined sex of the insect;

a water refilling mechanism for refilling water in the container, the water refilling mechanism comprising a water storage tank provided in fluid communication with the container, wherein the water storage tank is activatable by the controller to release water into the container upon detection of the water level in the container being below the predetermined water level by a water level sensor.

2. The smart insect trap according to claim 1, wherein the number of killing mechanisms include an electrifiable netting provided across the container above the predetermined water level to electrocute insects that come into contact with the electrifiable netting when the electrifiable netting is activated by the controller.

3. The smart insect trap according to claim 2, wherein the number of killing mechanisms include an ultrasonic transducer provided in the container below the predetermined water level to generate ultrasonic waves configured to kill insects in the water when the ultrasonic transducer is activated by the controller.

4. The smart insect trap according to claim 2 or claim 3, wherein the number of killing mechanisms include a rotatable blade configured to kill insects in the water when the rotatable blade is activated by the controller.

5. The smart insect trap according to any one of claims 2 to 4, wherein the smart insect trap further includes a netted portion provided across an opening provided at a bottom of the container, the netted portion configured to allow passage of water and to prevent passage of insects therethrough, wherein the smart insect trap further includes a valve provided in the opening at the bottom of the container, and wherein the controller is programmed to open the valve periodically to drain water from the container and retain insects in the netted portion to be killed by dehydration over time in the netted portion.

6. The smart insect trap according to any one of the preceding claims, wherein the killing mechanisms are provided in a first portion of the container and the water storage tank is provided in fluid communication with a second portion of the container, wherein the first portion and the second portion are separated by a screen configured to allow passage of water therethrough and to prevent passage of insects therethrough.

7. A smart insect trapping system comprising:

a number of the smart insect traps according to any one of claims 1 to 6; and

a main server with which the processor of the sensing portion of each smart insect trap is communicatively connected via the Internet, wherein information obtained by the processor of each smart insect trap is transmitted to the main server for processing and wherein results obtained from the processing can be downloaded for viewing by clients of the main server.