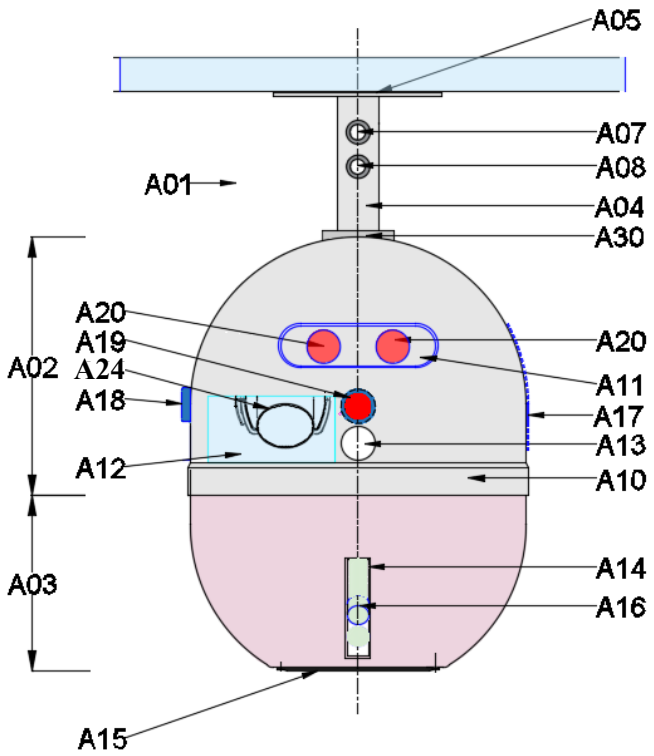
Title

An Artificial Intelligence analytic based Laser Beam Bird Repellent System for Indoor use.



Field of the Invention

This invention relates generally to a Pest Repellent system. In particular, this invention relates to a Pest Repellent system solely for Indoor use to provide an indoor area from Birds against roosting, food scavenging and posing a hygiene risk to humans.

Background

The conventional Canteen, Cafeteria, Eateries, Market places, etc are indoor structures for humans to congregate to store, purchase, procure cooked food, uncooked food and food waste; these usually becomes a source of attraction for pests such as birds, rodents, etc to either nest, seek shelter or scavenging, and they will bring along a hygiene risk to food safety.

There are no known effective means of deterring pests from indoor structures. Pests (primarily birds such as mynah, pigeons, crows, seagulls, etc) may be fearless of humans and work collectively to ensure no harm comes to them during scavenging. The teamwork among birds requires one bird to be perch at high ground acting as a scout for the area of preying, who will direct other scavenging birds to the food when it is left unattended. This task is rotated until all birds have eaten their fills.

The solution to this indoor pest problem has been human intervention is usually the sole method in deterring pests but usually happens after the food or food waste has already been attacked by the pest. Mitigation of food leftover through regular table cleaning to unmanned disposal centers helps to reduce pest infestation but is not efficacious.

Brief Description

1) In accordance with a first aspect of this invention, there is provided an external frame A1, A02, A03 in the form of a dust-free, non-metallic construction and having at least the following elements forming a popsicle shape apparatus; a first member A03 being a turret base and a second member A02 being the turret of equal halves forming a capsule body and a third memberA1 being support stem connecting both halves to the structure which the self-contained apparatus is suspended.

2) The first half capsule member A03 shall have a protruded sill that extends beyond the cylindrical edge of the second half capsule member A02, providing immediate cover against dust from entering the apparatus.

3) The construction of the support stem A1 consist of a flat plate A05 is welded to one end of steel stem A04 made of round hollow section with the other end threaded for a distance of 30-50mm. Apertures are preferably formed on the steel stem, one/ more above the capsule and one or more inside the turret base A18 along the same generatrix as the former; these machined apertures permit the entry of cables from the components inside the capsule to be connected to an external control panel. The flat plate A05 allows the stem to be held and anchored against the structure without any form of welding which may damage the existing steel member; wherein the flat plate A05 to be adjusted accordingly for true level and plumb.A EPDM grommet A30 is laid over the oculus of the dome of the turret base allow it to accept the stem which extent from the soffit of the structure penetrates into the core of the capsule pass the annulus base plate for the turret base A10, where it is received by sealed castor bearing A32 and an internally threaded steel plate that will adjust the final height of the capsule and carry the entire weight of the capsule with the balancing of the turret base on other parts of the annulus support plate by crossed roller skewing bearing A15 with inward facing gears A26 attached to the perimeter of the A10 turret plate.

4) Also, on the external body of the A02 cap, a number of apertures are preferably formed to allow the fixing of devices with indicating, controlling or sensory function relating to the external parameters. A A12 clear acrylic cover is applied over the opening located in front of the A24 CCTV camera and when removed allow the camera to be extracted and replaced during maintenance.

5) On the external body of the A03 body, is a narrow, vertical embrasure A14 is formed at the front of the turret body along with an opening for bottom dish shaped access cover A15 made of the same material as the capsule body for functional checks of components and mechanism only, which allow the entire apparatus to be laid on the ground easily.

6) Inside the Capsule body, is a metallic mechanism design use for setting the azimuth of the upper level laser guns to map upper space over the area of coverage. The A19 gear that determines the angle of tiltation to the y-axis is controlled by a removable lug wrench through one of the above described apertures along the same directrix of the turret body. A similar mechanical set up is avail for the IP based A24 CCTV camera with the azimuth set at the lower space of the area of protection. A13 noise cancelling condensing microphone is placed inside the A11 aperture at the front of the turret base body, with other apertures with about similar diameters are fitted with a A13 rapid strobe indicator “system normal” indicator and a A19 emergency stop (kill switch) button; whwerein to remove and replace the laser gun/s, the front cover A14 over these gun/s needs to be removed first, and the gun/s can be extracted by manually and replaced by a working piece simply through snap on contact with the A21 neodymium magnet type power adapter. To remove and replace the A24 CCTV camera, the A17 side access panel and A12 front acrylic cover needs to be removed first, followed by disconnecting the A32 multiple pin adapter.

8) Inside the rotary turret body is a A13 metallic mechanism to achieve pan-tilt function by setting the azimuth of low-level A16 laser gun/s within the A14 embrasure and similarly to the above-mentioned laser gun/s in the y-axis along with the horizontal rotary action.

9) The function of the A34 condensing microphone is to capture the sounds from any bird/s inside the indoor structure where the audibility is identified from the pitch and frequency and compared against pre-trained CNN to ascertain if it is Bird/s; wherein this function is used for high space of the area of protection where visual detection is not suitable due to the numbers of structural elements that may conceal the Bird/s from sight, that the Bird/s at this position is either roosting or scouting and not scavenging.

10) The function of the IP based fixed A24 CCTV camera is to capture the presence of bird/s and human, particularly the latter who may be intimate with the apparatus when servicing it, may be exposed to sudden discharge of laser beams. An optional attribute is to capture the presence of fire. The operation of the A24 CCTV camera is set at the low space of the area of protection where visual recognition is based on the entire Bird and for human, the head and top torso of the body. The data for lower torso for AI analytic is dumped to expedite the data processing time. AI analytic for both human and bird/s is based on shape and size scalability whilst the AI analytic for optional fire/ smoke detection is based on color, texture and size scalability.

11) Upon matching the audible recording against pre-trained CNN for bird sound, the upper level A20 laser gun/s will be activated for a duration of about ten (10) seconds

12) Upon matching the video imaging of the area of protection against the pre-trained CNN for bird shape, the low-evel A16 laser gun/s will be activated for a duration of about seven (7) seconds.

13) When the A20 or A 16 laser gun/s is activated, variant attributes in context of disruptive dissonance, from time duration, intensity non- linear polarisation at plane are applied to ensure zero consistency at each beam discharge, so as to confuse the bird/s ability to adapt through cognitive learning.

14) The A24 CCTV will continue to monitor presence of bird/s after the first discharge, and emit a second discharge after a time lapse of ten (10) seconds, and upon fourth event, an extended beam duration of about 3 minutes with maximum intensity will be applied.

15) A possible combination of A16 laser gun/s on active duty and standby dun may be applied in the apparatus. A photo beam sensor A36 will be placed inside the apparatus that will detector the discharged laser gun/s when it is activated and compared event.

16) In simplified form, the invention may still exist as a self-contained apparatus but the mode of operation may be attributed to 2.4GHz remote activation, controlled by smartphone application, timer activation or by localised control of momentary switch.

17) In further simplified form, the self-contained apparatus may not require A24 CCTV camera and/ A34 condensing microphone to operate with the above described attributes for non-automatic function/s.

Detailed Description

1. A number of preferred embodiments of the apparatus and method for repelling birds inside an indoor structure are described, wherein numerous details are provided to offer a thorough description of these embodiments, wherein the invention may be practiced without such details, and wherein well-known details are omitted to avoid obscuring the invention.

2. The advantages of the preferred embodiments of this invention are manifold; one advantage is that it mitigates the nuisance posed by birds and the associated health risks by repelling them using low-powered laser beams in a humane way without injuring or culling them, while another is that it prevents birds from adaptive learning through the cognitive behavior of a robotic, fixed-action apparatus; additionally, this invention is particularly advantageous for open food courts, hawker centers, and wholesale markets.

3. Referring to the above, the area of protection where herein is defined as a structure with an indoor space that shelters humans from weather elements and provides food attraction to pests, where herein define the space may or may not be enclosed along its sides; wherein pest infestation or ingress cannot be effectively prevented from entering for the purpose of roosting or food scavenging

4. Referring now to Figures 1 to 3, a first preferred embodiment of the apparatus A1 is illustrated, where herein define overall construction of the invention, showcases the aesthetic aspect and external functions of the apparatus, as well as the method for repelling birds from the area of protection in accordance with this invention; wherein the external frame of the popsicle-shaped apparatus, size of approximately 400 mm in diameter and 750 mm in height, is made of a non-metallic construction, preferably fiberglass or plastic polymer, and/ is fabricated using a 3D printer; the frame comprises at least the A02 second first half capsule member, which features an A10 protruded sill extending beyond the cylindrical edge of the A03 3rd capsule member; this sill is designed to protect the internal components of the apparatus from dust, pests, and unauthorized entry; wherein the construction of the A01 first member with the A04 support stem consists of an A05 flat plate welded to one end of a steel stem, which is made of a round hollow section, with the opposite end threaded for a length of 30-50 mm; the apparatus is designed for static mounting, to be suspended at a height of 3 m or higher (measured from the finished floor level), in a fixed, pre-defined location based on the spatial limitations of the software's radial coverage over the area of protection; apertures are preferably formed on the A04 steel stem, including one or more A07 and A08 apertures above the capsule, and one A09 aperture inside the turret base along the same generatrix as the former; these machined apertures allow the entry of cables from the internal components of the capsule to be connected to an external control panel; the A05 flat plate enables the stem to be anchored against the structure without welding, which may damage the existing steel member, and allows for adjustments to ensure the stem is level and plumb.

5. Included in the first embodiment herein define the mechanical fitment to support and rotate the A1 apparatus is an A30 EPDM grommet with an inner diameter of about 50mm, which is laid over the oculus on the dome of the A02 Capsule body turret base, allowing it to accept the stem that extends from the soffit of the structure and penetrates into the core of the capsule, passing through the A31 annulus base plate for the turret base, where it is received by the A32 sealed castor bearing and an A33 internally threaded steel plate, which adjusts the final height of the capsule and supports its entire weight, balancing the turret base on other parts of the annulus support plate via the A25 crossed roller skewing bearing with inward-facing gears attached to the perimeter of the A31 annulus base plate.

6. Continue with the above, this describes the external features on A02 Cap where herein define the various devices located in A02 cap; the A19 emergency button (latching type) powers down the A1 apparatus and can only be restarted when unlatched, thus giving control to the technician working on it at high level; wherein faulty parts identifiable by the number of flashes from the strobe indicator; the A13 microphone adds an additional layer of bird detection in areas where line of sight is impossible, as referenced in Claim/Para 14.

7. Included in the first embodiment and illustrated in Figure 1-3, where herein define the devices on the surface of A03 capsule body a A14 narrow, vertical embrasure used for A16 laser gun/s measuring 25mm wide by 200mm long at the front of the turret body, along with an approximately 250mm diameter opening for the A15 bottom dish-shaped access cover, made of the same material as the capsule body, which facilitates functional checks of components and mechanisms, allows the entire A1 apparatus to be easily laid on the ground.

8. Referring to Figures 2, 4, 5, and 6, a second preferred embodiment where herein define the functional and operational aspects of the A1 apparatus; A21 is a mechanical setup inside the A02 cap and with the A39 gear controlling are used to set the azimuth of the A20 upper-level laser guns in the X-axis and Y-axis respectively, wherein the latter can be adjusted using a removable lug wrench through one of the previously described apertures along the turret body's directrix; the removal and replacement of the A20 laser guns being with the removal of the A11 front cover, after which the guns can be extracted and replaced with a working unit via Snap-On magnetic contact with the A34 neodymium magnet-type power adapter; a corresponding A32 mechanical setup adapter base is provided for the A24 IP-based CCTV camera, with the azimuth set to the lower space of the bounding area, and removal/ replacement of the A24 CCTV camera require removal of the A17 side cover and A12 front acrylic cover, followed by disconnecting the A36 multiple-pin adapter and releasing the A24 CCTV camera from the A32 adapter base.

9. Referring to Figures 1, 2, and 5, a third preferred embodiment where herein define an audible detection system is incorporated inside the turret base; an A13 noise-cancelling condensing microphone is placed inside the aperture located at the front of the turret base body; the A20 laser/s depend on both A24 CCTV and/or A13 microphone to activate, with the A24 CCTV and/or A13 microphone being set in the same general direction as the A20 laser/s; additionally, referring to Figures 10, 11, and 18, blind spots behind the invention are addressed by placing the same apparatus in a direct opposite position within the bounding area; the inventive steps include using sound to classify birds for activation of the upper laser/s, which differs from other inventors who rely solely on video AI detection, and employing two or more apparatuses in opposite directions to address blind spots, a solution that sets this invention apart from others that use a single apparatus and do not consider or resolve blind spots.

10. Referring to Figures 1, 2, and 5, a fourth preferred embodiment where herein define function of AI used for detection of classifier/s; wherein the video detection is provided by an A24 IP-based self-contained CCTV camera capable of supporting AI analytics, with built-in functionality via Random Access Modules and/or Read-Only Modules for coding and image processing; the AI analytic function depends on video detection of birds/humans and fire/human via the A24 CCTV camera; the AI analytic function also depends on audible detection of birds through the A13 microphone.11. Referring to Figures 1, 2, and 5, a fifth preferred embodiment of the apparatus A01 is illustrated, in which the turret base includes an A19 rapid strobe indicator, an A33 "system normal" indicator, and an A18 emergency stop (kill switch) button; to remove and replace these buttons, the A17 side access panel is first removed, followed by the removal of the lock nut, after which the switch is replaced, and the respective switch is then fixed back into position using the lock nut.

11. Referring to Figures 1, 2, and 5, a fifth preferred embodiment where herein defined as access doors, control and monitoring devices featured on the surface of A02 cap; wherein is A19 rapid strobe indicator, A33 "system normal" indicator, and A18 emergency stop (kill switch) button; access to these devices, including the A20 upper lasers, A24 CCTV, and A19 flash indicator light, is provided through the A17 side cover; any faulty parts can be identified by the number of flashes of the strobe; the removal and replacement of the buttons or switches can be achieved by releasing the lock nut inside the A02 cap; after releasing the lock nut, the switch is replaced and fixed back into position using the lock nut.

12. Referring to Figures 2, 4, and 6, a sixth preferred embodiment describe herein within A03 body is the A40 mechanism setup designed to achieve the pan-tilt function by setting the azimuth of the A16 low-level laser gun(s) in the Y-axis and X-axis using the A39 steering sector gear and the A40 rotary assembly comprising of the A10 turret plate, A32 sealed castor bearing, A33 threaded plate, A25 inward gear respectively; both being driven by A23 and A38 servo motor respectively.

13. Referring to Figure 17, a seventh preferred embodiment define herein the electrical structure, featuring a separate local motor control panel (LMCP), which may be suspended from the structure; the control panel consists of a miniaturized circuit breaker for incoming power supplies, a step-down transformer cum trickle charger that reduces incoming power to 12 Volt direct current, a sealed lead-acid battery, indicator lights, test switches, Fault/Normal/Charger fail/Fire (optional) LED indicators, a scrolling LCD display, and a master controller card, which includes a voltage modulator, an E2PROM module embedded with faster R-CNN coding, a ramdrive, a removable solid-state hard disk, and a SIM-based wireless router; while the LMCP incorporates all of these features, it also includes a self-diagnostic function to ensure routine system initialization checks and fault reporting, with the step-down transformer, trickle charger, cabling, and other components serving more than one A01 apparatus at a time, and the CPU coded to establish an address for each apparatus, conduct the diagnostics, and report any faults, thus enabling the LMCP to provide AI processing and power supply to multiple A1 apparatus, while identifying and managing actions for bird, human, fire detection, and corresponding responses based on the assigned addresses.

14. Referring to the above, an eighth preferred embodiment herein define the interface of visual/ audio devices with AI and how the classifier are being identified; wherein AI analytic software designed to work with the A13 condensing microphone to capture sounds from any birds inside the indoor structure, where the audibility is identified by pitch and frequency and compared against a pre-trained CNN to determine if it is a bird; this function is particularly useful in high spaces of the area of protection, where visual detection is challenging due to structural elements that may conceal the birds, enabling the system to identify whether the birds are roosting or scouting rather than scavenging; wherein the A24 IP-based fixed CCTV camera captures the image of both birds and humans, especially humans who may be in close proximity to the apparatus during servicing and could be exposed to sudden laser beam discharges; the CCTV camera operates at the lower space of the area of protection, where visual recognition is based on the entire bird and the head and top torso of the human body, with data for the lower torso being discarded to expedite data processing; AI analytics for both birds and humans is based on shape and size scalability; an optional feature of the AI analytic software is the ability to detect fire and smoke, where the AI analysis for fire/smoke detection is based on color, texture, and size scalability; upon matching the fire/smoke algorithm, the CPU sends a signal output to an electrical connector that can be linked to a visual or audible alarm.

15. Referring to the above where herein define the methodology of Artificial Learning AL, the pre-trained CNN involves an initial setup that includes several inputs of an empty interior with no human or pests present, which forms the bounding box for analysis and serves as the backdrop for the pre-trained CNN; for video recognition, pooling images are continuously introduced, and regional proposals for the established background are parsed to develop the classifier, which is based on shape and size for both humans and birds; for audible recognition, the background noise is analyzed against the frequency and pitch emitted by selected birds to match the classifier; for optional visual recognition of fire, the color spectrum and size scalability for fire, and separately the texture spectrum and size scalability for smoke, are used to identify their presence.

16. Referring to the above Claim/Para 14 & 15 where herein define the area of protection within the AI domain for the low-level area covered by the A24 CCTV camera is defined, with the schematic for visual and audible sources for bird and human indicated in Table 1; the initial setup involves using the A24 CCTV to capture and pool visual images of the domain with no human or bird present, forming the bounding box for analysis; the AI processor depends on audio recognition of birds based on pitch and frequency against background noise; and the AI is further dependent on the Region Proposal Network (RPN) or faster Regions with Convolutional Neural Networks (R-CNN) method for visual recognition, utilizing a support vector machine to set up classifier segmentation in object detection through deep machine learning.

Table 1: Summary of Classifier used to identify Human, Birds and Fire Classifier	Visual recognition				Audible recogni-tion
	Colour	Size scalability	Shape	Texture	
Human	Exclude	Yes	Head and Upper torso	Exclude	
Human	Exclude	No	Head and eyes only		
Bird	Optional	No	Full body	Exclude	Bird's chirping
Alternative fire	Yes	Yes, minimum of 0.75m^2	No	Optional for smoke, minimum of 2m^2	

17. Referring now to Figures 8 to 15, a ninth preferred embodiment herein define how the classifier being bird, human or fire, herein define the duration time for A16 low level laser discharge, numbers of discharge and laser characteristics, where, upon matching the video imaging or audible sound of the area of protection against the pre-trained CNN for bird shape, the A16 low-level laser gun(s) are activated for a duration of about seven seconds; when the A16 or A20 laser gun(s) are activated, variant attributes such as disruptive dissonance, time duration, intensity, and non-linear polarization at the plane are applied to ensure zero consistency in each beam discharge, thus confusing the birds' ability to adapt through cognitive learning; as part of these attributes, the A35 vibration chipsets attached to the aforementioned laser gun(s) are also activated simultaneously with the respective laser gun(s), as summarized in the following table; additionally, the A17 IP-based CCTV continues to monitor the presence of birds after the first discharge and emits a second discharge after a time lapse of ten seconds, with an extended beam duration of about three minutes and maximum intensity applied upon the fourth discharge; included in the above attributes is the possible combination of A16 laser gun(s) on active duty and standby, with a photo beam sensor placed inside the apparatus to detect the discharged laser gun(s) when activated and compare the event; further, included in the above attributes are the key characteristics of the high-powered laser pointer (Class 2 or lower, beam color: green and/or blue, wavelength: 380 nm to 600 nm, power rating: ≤1 watt) with diffraction grating lens; referring to Figures 2, 4, and 6, a sixth preferred embodiment of the apparatus A01 is illustrated, in which an A21 vibrator chip is affixed to the laser gun to overcome static beam projection through rapid movement, disrupting the cognitive behavior of birds toward the apparatus as a non-threat; an optional high-powered, upper-level laser gun fitted with multiple lenses, with beam output mounted at the top of the enclosure and projecting laterally for a minimum coverage of 180-degree radial distribution, may also be included; and a secondary laser gun placed parallel to the primary laser gun for design redundancy may be utilized when the latter is non-operational, reducing the mean time between failure of the apparatus.

Table 2: Summary of Classifier used to identify Human, Birds and FirePest repellent operation	Activation	Birds	Human away from apparatus	Human intimate with apparatus[1]
Low level laser gun with diffraction grating len, inside turret	Visual recognition	Activate for 7±2 seconds maximum, paused for 10 s minimum. (adjustable)	Continue to operate if no human face detected (Optical safety protection)	Disable function immediately (Optical safety protection)
High level laser gun with multiple lens, inside turret base	Audible recognition	Activate for 107±2 seconds (adjustable)	Not applicable	Disable function immediately (Optical safety protection)

18. Referring to the above, a rotary function for the laser gun(s) herein define how to apply the laser in large area or high human density to manage the protection of large areas or high-density human presence, who may suffer optical injury from the laser beams, by limiting the extent of beam projection onto the target area through adjusting the spatial distance between the bulb and lens or the lens diopter value; whereas projecting laser light over an extended target area may pose health risks to humans, the target area can be reduced to approximately 10m² by adjusting the laser gun lens to reduce the beam projection area over the entire protection area simultaneously; when the extent of beam projection is reduced, compensation for coverage is made by allowing the laser gun to move to the target area where birds are detected by the A24 IP-based camera; in this instance, the ability of the laser light to cover the entire protection area is managed by a pair of servo motors that direct the laser gun(s) to the correct horizontal and vertical axis; for horizontal movement, the A38 servo motor affixed directly to the inside diameter of the A25 skew rings at the turret base is adjusted in forward/reverse motion within a radial span no larger than the field of view of the fixed camera at the A10 turret base, which is no larger than a 40-degree angle; when the horizontal axis of the turret/laser gun matches the target area, the vertical axis of the pinion-mounted laser gun is activated for a vertical up-down sweep within a 30-degree angle span via another A23 servo motor affixed directly to the vertical pinion; and the movement of either servo motor is powered by direct current, intrinsically safe low voltage, reversible through polarity switching, and controlled by a contact-type limit switch to prevent motor overrun.

19. Referring now to Figure 16, a tenth preferred embodiment herein defines the microphone as the activator and the laser discharge duration time of A20 high level where, upon matching the audible recording captured by the A13 microphone against the pre-trained CNN for bird sound, the AI processor analyzes the pitch and frequency relative to background noise, and subsequently activates the A20 upper-level laser gun(s) for a duration of about ten (10) seconds to target the identified bird presence in the high space of the structure.

20. Referring now to Figure 2 and Figure 4, an eleventh preferred embodiment herein defines as manual activation of the A16 laser, wherein activation mode of the A16 laser is facilitated by 2.4Hz remote control, smartphone app, timer, or localized control through a momentary switch; in this simplified version, the need for automatic seek-and-fire functions is eliminated, as the target bird is consistently located in a designated area, such as a tray holding area, and the apparatus operates without the need for the A24 CCTV camera or A13 condensing microphone.

21. Referring now to Figure 2 and Figure 4, a twelfth preferred embodiment where herein defined as , wherein defined as manual activation without A24 CCTV and A13 microphone; wherein the A20 laser is manually activated via a momentary switch by an operator who observes birds hidden at high levels inside the premises; in this simplified version, the apparatus does not require the A24 CCTV camera or A13 condensing microphone, and automatic seek-and-fire functions are unnecessary, as the birds are consistently located in a specific area, such as a tray holding area.