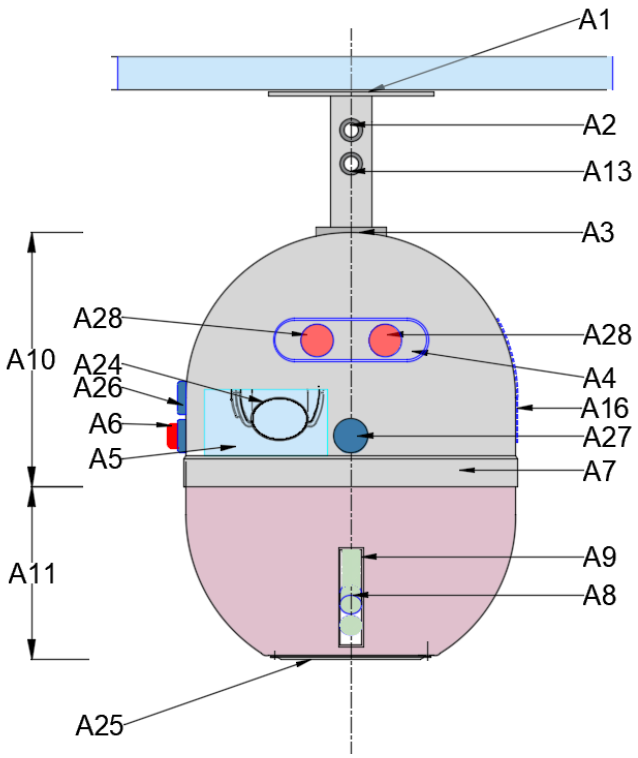
Title

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.

1) In accordance with a first aspect of this invention, there is provided an external frame 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 being a turret base and a second member being the turret of equal halves forming a capsule body and a third member being support stem connecting both halves to the structure which the self-contained apparatus is suspended.

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

3) The construction of the support stem consist of a flat plate is welded to one end of steel stem 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 above the capsule and one or more inside the turret base 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 allows the stem to be held and anchored against the structure without any form of welding which may damage the existing steel member and to be adjusted accordingly for true level and plumb.

4) A EPDM grommet is laid over the oculus over 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, where it is received by sealed castor bearing 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 with inward facing gears attached to the perimeter of the plate.

5) Also, on the external body of the turret base, 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 clear acrylic cover is applied over the opening located in front of the apparatus for the operation of the CCTV camera and when removed allow the camera to be extracted and replaced during maintenance.

6) On the external body of the turret, is a narrow, vertical embrasure is formed at the front of the turret body along with an opening for bottom dish shaped access cover 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.

7) Inside the turret base body, is a metallic mechanism design use for setting the azimuth of the upper level laser guns to math upper space over the area of coverage. The 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 CCTV camera with the azimuth set at the lower space of the area of protection. A noise cancelling condensing microphone is placed inside the aperture at the front of the turret base body, with other apertures with about similar diameters are fitted with a rapid strobe indicator, “system normal” indicator and a emergency stop (kill switch) button. To remove and replace the laser gun/s, the front cover 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 neodymium magnet type power adapter. To remove and replace the CCTV camera, the side access panel and front acrylic cover needs to be removed first, followed by disconnecting the multiple pin adapter.

8) Inside the rotary turret body is a metallic mechanism to achieve pan-tilt function by setting the azimuth of low-level laser gun/s within the 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 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. 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 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 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 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 lower level laser gun/s will be activated for a duration of about seven (7) seconds.

13) When the 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 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 laser gun/s on active duty and standby dun may be applied in the apparatus. A photo beam sensor 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 CCTV camera and/ condensing microphone to operate with the above described attributes for non-automatic function/s.

1. A number of preferred embodiments of the apparatus and of the method of repelling the birds inside the indoor structure are described. In the following description of the preferred embodiments, numerous details are described in order to provide a more thorough description of these embodiments. It becomes apparent to one skilled in the art, however, that the invention may be practised without such details. In other instances, well-known details have not been described at length so as not to obscure the invention.

2. The advantages of the preferred embodiments of this invention are manifold. One advantage is that nuisance posed by the Birds and the associated health risk can be mitigated, through repelling the birds using low powered laser beams and is done in a humane way without injuring or culling them. Another advantage is that invention takes further steps to prevent Birds from adaptive learning through cognitive behaviour of a robotic, fixed action by the apparatus. This invention is particularly advantageous for open food courts, hawker centers and wholesale market. Another advantage of the embodiment of this invention is that cleaners are more likely to buy and use this implement to clean windows if it is relatively simple, lightweight and safe.

3. Referring to the above, the area of protection is defined as a structure with an indoor space which harbours human from the weather elements and provide food attraction to the pests. The space may or may not be enclosed along its sides where pest infestation or ingress cannot be adequately or effectively prevented from entering it for purpose of roosting or food scavenging.

4. Referring now to Figure 1 and Figure 3, there is illustrated a first preferred embodiment of the apparatus A01 which is the aesthetic aspect and external functions of the said apparatus and a method for repelling birds from area of protection in accordance with this invention.

   The external frame of the popsicle shaped apparatus, capsule size approximately 400mm diameter, 750mm high shall be manufactured in a non-metallic construction preferably in fibreglass material or plastic polymer using 3D printer, comprises of no less than A02 first half capsule member which has a A10 protruded sill that extends beyond the cylindrical edge of the second half A03 capsule members, that is intended to protect the components inside this enclosure from dust, pests and unauthorised entry, from infiltrating/ accessing the apparatus.

   The construction of the A04 support stem consist of a A05 flat plate is welded to one end of steel stem made of round hollow section with the other end threaded for a distance of 30-50mm. The apparatus shall have static mounting, be suspended at a height of 3m or higher (measure from finished floor level) in a fixed, pre-defined location based on the spatial limitation of the software radial coverage over the area of protection.

   Apertures are preferably formed on the A04 steel stem, one or more A07, A08 above the capsule and one A09 inside the turret base 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 A05 flat plate allows the stem to be held and anchored against the structure without any form of welding which may damage the existing steel member and to be adjusted accordingly for true level and plumb.

5. Included in the first embodiment is an A30 EPDM grommet with inner diameter of about 50mm is laid over the oculus over the dome of the A02 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 A31 annulus base plate for the turret base, where it is received by A32 sealed castor bearing and an A33 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 A25 crossed roller skewing bearing with inward facing gears attached to the perimeter of the A31 annulus base plate.

6. Also included in the first embodiment and on the external body of the A02 turret base, a number of apertures are preferably formed to allow the fixing of devices with A19 indicating, A18 controlling or A20 sensory function relating to the external parameters. A13 a clear acrylic cover clear approximate size 200mm x 120mm high, is applied over the opening located in front of the apparatus for the operation of the A27 Fixed IP CCTV camera and when removed allow the camera to be extracted and replaced during maintenance.

7. Included in the first embodiment and on the external body of the A03 turret, is a A14 narrow, vertical embrasure 25mm wide x 200mm long is formed at the front of the turret body along with an approximately 250mm diameter opening for A15 bottom dish shaped access cover 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.

8. Referring now to Figure 2, Figure 4, Figure 5 and Figure 6, there is illustrated a second preferred embodiment of the apparatus A01 which is the functional and operational aspect of the apparatus and inside the turret base body, is A21 a mechanical set up use for setting the azimuth of the A20 upper level laser guns to math upper space over the area of coverage.

   The 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. To remove and replace the A20 laser gun/s, the A11 front cover over these A20 gun/s needs to be removed first, and the A20 gun/s can be extracted by manually and replaced by a working piece simply through Snap-On magnetic contact with the A34 neodymium magnet type power adapter.

   Included in the second preferred embodiment and on inside the turret base is a similar A32 mechanical set up adapter base is avail for the A27 IP based CCTV camera with the azimuth set at the lower space of the area of protection. To remove and replace the A27 IP based CCTV camera, the A17 side access panel and A13 front acrylic cover needs to be removed first, followed by disconnecting the A34 multiple pin adapter and releasing the A27 IP based CCTV camera from the A32 adapter base.

9. Referring now to Figure 1, Figure 2 and Figure 5, there is illustrated a third preferred embodiment of the apparatus A01 inside the turret base, an audible detection via A13 a noise cancelling condensing microphone is placed inside the aperture located at the front of the turret base body.

10. Referring now to Figure 1, Figure 2 and Figure 5, there is illustrated a fourth preferred embodiment of the apparatus A1 inside the turret base, a video detection via a A27 IP based self-contained CCTV camera that is capable of supporting AI analytic with built in function via Random Access Modules and / Read Only Modules for Coding and image processing. Included in the fourth preferred embodiment is an AI analytic function to detect fire and/ smoke.

11. Referring now to Figure 1, Figure 2 and Figure 5, there is illustrated a fifth preferred embodiment of the apparatus A01 inside the turret base, A19 a rapid strobe indicator, A33 "system normal" indicator and A18 a emergency stop (kill switch) button. To remove and replace these buttons, the A17 side access panel is removed, follow by the lock nut, and the switch is removed and replaced and the respective switch is then fixed back into position by the lock nut.

12. Referring now to Figure 2, Figure 4 and Figure 6, there is illustrated a sixth preferred embodiment of the apparatus A01 and on inside the rotary A03 turret body is A35 a mechanical set up to achieve pan-tilt function by setting the azimuth of A16 low-level laser gun/s within the A14 embrasure and similarly to the above-mentioned A16 laser gun/s in the y-axis along with the horizontal rotary action.

13. Referring now to Figure 17, there is illustrated a seventh preferred embodiment of the apparatus A01 is a separate local motor control panel (LMCP) which may be mounted out of reach of most human suspended from the structure.

    The control panel shall consist of miniaturised circuit breaker for incoming power supplies and a step-down transformer cum trickle charger reducing incoming power to 12 Volt direct current, sealed lead acid battery, indicator lights, test switches, Fault/Normal/ Charger fail/ Fire (optional) LED indicators, scrolling LCD display and a master controller card, which comprise of a voltage modulator, E^2PROM module which is embedded with faster R-CNN coding, ramdrive and a removable solid state hardisk, SIM based wireless router.

    Whereas the LMCP may have all of the above attribute, an additional self-diagnostic function shall be incorporated to ensure system initialization checks are routinely conducted and fault reporting is made.

    Whereas the step-down transformer cum trickle charger, cabling, etc may be required to serve more than one (1) apparatus A01 at any one time, the CPU shall be coded such it is capable of establishing an address for each apparatus served, carry out the abovementioned diagnostic and fault reporting.

14. Referring now to above, there is illustrated a eighth preferred embodiment of the apparatus A01, an AI analytic software designed to work with the A13 condensing microphone 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. 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.

    Included in the eighth embodiment and the function of the A27 IP based fixed CCTV camera is to capture the image 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. The operation of the 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. An optional attribute of the AI analytic software is to capture the presence of fire/ smoke where the AI analytic for optional fire/ smoke detection is based on colour, texture and size scalability. Upon matching the fire/ smoke algorithm, the CPU shall send out a signal output to the electrical connector which can be connected to a visual/ audible alarm.

15. Referring to the above, the pre-trained CNN is an initial setup involves several inputs of an empty interior with no human or pest to form the bounding box for analysis and forming the backdrop of pre-trained CNN. For video recognition, pooling images will be constantly introduced and regional proposal for the established background are parsed to establish the classifier which is based on shape and size for both human and birds.

For audible recognition, the background noise is parsed against the frequency and pitch emitted by selected birds for classifier matching. For optional visual recognition of fire, the colour spectrum and size scalability for fire and separately texture spectrum and size scalability for smoke are used to identify their presence.

16. Referring to the above, the bounding box is defined as the virtual area that is bounded by each surveillance camera that when combined will form the area of protection. The bounding box will be parsed with the convolution layer that eventually predict the presence of the classifier which may be human or birds through visual detection.

The regional proposal established in each bounding box per iteration shall be used to match classifier, which is an ensemble of instructions, which maps the information of each image / audible of the human and birds on the following basis.

Table 1: Summary of Classifier used to identify Human, Birds and FireClassifier	Visual recognition				Audible recognition
	Colour	Size scalability	Shape	Texture	
Human	Exclude	Yes	Head and Upper torso	Exclude	
Human	Exclude	No	Head and eyes only[1]		
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 Figure 8 to Figure 15, there is illustrated a ninth preferred embodiment of the apparatus A01 where upon matching the video imaging/ audible sound of the area of protection against the pre-trained CNN for bird shape, the A16 lower level laser gun/s will be activated for a duration of about seven (7) seconds.

When the A16 or A20 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. As part of the attribute, the A35 vibration chipsets attached to abovementioned A16 or A20 laser gun/s are also activated simultaneously with the respective laser gun/s, as summarised in following table.

[1] When human is intimate with apparatus, design to prevent optical injury from laser gun

Table 2: Summary of Classifier used to identify Human, Birds and FirePest repellent operation	Activation	Birds	Human away from apparatus[2]	Human intimate with apparatus[1]
Low level laser gun[3] 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)

The A17 IP based 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.

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

Included in the above attributes is the key characteristics and attributes of the high powered, laser pointer (Class: 2 or lower, Beam colour: green and/ blue, Wave length: 380 Nm to 600 Nm, Power rating: ≤1 Watts) with diffraction grated lens.

Referring now to Figure 2, Figure 4 and Figure 6, there is illustrated a sixth preferred embodiment of the apparatus A01 and A21 a vibrator chip will be affixed to the laser gun to overcome the static beam projection through rapid movement that will disrupt cognitive behaviour of birds toward the apparatus as non-threat.

Option of high-powered, upper level laser gun fitted with multiple lens with beam output mounted at top of the enclosure with beams projecting laterally for a minimum coverage of 180-degree radial distribution.

Option of a secondary laser gun/s to be included in the apparatus placed parallel to the primary laser gun for the purpose of design redundancy which may be utilized when the latter is non-operational to reduce mean time between failure of the apparatus.

[2] Whereas the surveillance camera discovered human face/s starring directly at the direction of the apparatus or human face in close proximity of the apparatus, the laser gun shall be disabled from functioning to prevent optical injury.

[3] Whereas the laser beam is activated on detection of birds, the beam will project onto the diffraction grating len will cause divergence net effect at the target area which embodied the entire area of protection. The projection from the laser gun shall not exceed the duration of more than five seconds at any single instance, with a lapse of another ten seconds minimum time delay between activation.

18. Referring now to the above, there is illustrated is a rotary function for the laser gun/s to manage protection of large area or large density of human presence who may be suffer optical injury from the laser beams, by limiting the extent of beam projection onto the target area by adjusting the spatial distance between bulb and len or len diopter value.

    Whereas it is deemed projecting laser light over extended target area may have health risk concerns[4] for humans, the target area may be reduced to a portion of the area of protection of approximately $10m^2$, by adjusting the laser gun lens to reduce the beam projection area over the entire area of protection simultaneously. When the extent of beam projection is reduced, compensation for coverage is made by allowing the laser gun to be moved to target area where Bird/s was detected by A27 IP based camera. In such instance, ability of the laser light to cover the entire area of protection is managed by a pair of servo motors to direct the laser gun/s to the correct horizontal and vertical axis.

    For horizontal movement, the servo motor affixed directly to inside diameter of the skew rings at the turret base is adjusted in forward/ reverse motion within a radial span not larger than the field of view of the fixed camera at the turret base, which is no larger than 40-degree angle.

    When the horizontal axis of the turret/laser gun matches the target area, the vertical axis of the pinon mounted laser gun will be activated for vertical up-down sweep within a 30-degree angle span via another servo motor affixed directly to the vertical pinion.

    The movement of either servo motors shall be powered by direct current, *intrinsically* safe low voltage, reversible through polarity switching and controlled by contact type limit switch that prevent motor overrun.

19. Referring now to Figure 16, there is illustrated a tenth preferred embodiment of the apparatus A01 where upon matching the audible recording against pre-trained CNN for bird sound, the A20 upper level laser gun/s will be activated for a duration of about ten (10) seconds

20. Referring now to Figure 2 and Figure 4, there is illustrated a eleventh preferred embodiment of the apparatus A01 which is a 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.

21. Referring now to Figure 2 and Figure 4, there is illustrated a twelfth preferred embodiment of the apparatus A01 which in further simplified form, the self-contained apparatus may not require CCTV camera and/ condensing microphone to operate with the above described attributes for non-automatic function/s.

22. Referring now to Figure 2 and Figure 4, there is illustrated a eleventh preferred embodiment of the apparatus A01 which in further simplified form, the self-contained apparatus may not require CCTV camera and/ condensing microphone to operate with the above described attributes for non-automatic function/s.

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[4] Use of Class 2 or lower (< 1Watt power rating) laser beams are generally deemed to be safe.