한국기계가공학회지, 제19권, 제8호, pp.15～21(2020.08) ISSN 1598-6721(Print)
Journal of the Korean Society of Manufacturing Process Engineers, Vol. 19, No. 8, pp.15～21(2020.08) ISSN 2288-0771(Online)

https://doi.org/10.14775/ksmpe.2020.19.08.015

A Study on Bird Deterrent System to Improve the Performance of Repelling Harmful Birds

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유해조류 퇴치 효과 향상을 위한 퇴치시스템 개선

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(Received 30 June 2020; received in revised form 28 July 2020; accepted 03 August 2020)

ABSTRACT

We improved the sound pressure of the speaker and allowed the speaker to rotate 360 degrees to improve the effectiveness of the acoustic type bird repellent system. The prototype of the bird repellent system was developed by evaluating sound pressure characteristics by distance and direction and installing orchards. As a result of the evaluation, the extermination sound pressure increased from a distance of about 30 m to a maximum of 60 m, and through the rotary speaker, the extermination distance could be widened in all directions without specific direction.

Key Words : Bird Repeller(조류퇴치기), Rotating Bird Deterrent System(회전형 조류퇴치시스템), Sound of Natural Enemy(천적음)

1. Introduction

Various eco-friendly movements have recently led to a rapid increase in the number of wild animals. Correspondingly, damage to crops due to animals has increased, leading to conflicts between wild animals and farmers. In particular, birds have been found to severely damage fruit trees, including those that fall under high-value-added farming (including apples, cherries, and pears), thus warranting the urgent implementation of countermeasures. Passive methods to deter harmful birds, such as scarecrows, bagging grains, installation of nets or fences, and hunting, have already been proved to be inadequate, and commercially available electronic deterrent

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systems, regardless of visual acoustic or vibration types, are not widely distributed among farmers owing to their high prices and insignificant effects.[1~8]

In this study, the authors propose a bird deterrent system that can be applied at actual farming sites by adding an acoustic unit and a laser generator with a 360° rotating structure to expand the deterrence area of a previously proposed bird deterrent system[9].

2. Subject

2.1 Comparison of Bird Deterrent System Specifications

The conventional fixed-type bird deterrent system[9] can be installed on stanchions in orchards to deter birds in an acoustic manner by playing back diverse types and patterns of sounds. However, in terms of instrumentation, the conventional system is analogous to the structure in which a speaker is fixed to the main body.

Fig. 1 Existing bird repellent system

Table 1 Comparison of repellent system specifications

Parameters	Existing	Improve
Sound pressure level of speaker	110 dB(A)	127 dB(A)
Rotation angle	0°	360°
Power	Battery	Solar module
Light	×	Laser module

In this case, the ability of the system to widen the deterrence area is limited because the sound is reproduced only along the installation direction. Fig. 1 shows a diagram of the conventional bird deterrent system installed in a farm.

The improved bird deterrent system has been designed with a 360° rotating structure comprising an acoustic unit that generates sounds associated with adversaries of birds; the sound pressure level has been improved by changing the speaker specifications, and a laser module has been added to provide a visual deterrent effect in order to maximize the deterrent effect on birds and increase the deterrence area. Table 1 compares the major specifications of the conventional bird deterrent system and the improved bird deterrent system.

2.2 Configuration of Improved Bird Deterrent System

The improved bird deterrent system consists of a rotating speaker to improve the directionality of sound and a rotating laser module in the top portion of the system to add visual deterrence. Furthermore, this improved system employs a photovoltaic (PV) module so that users need not have to replace the system battery.

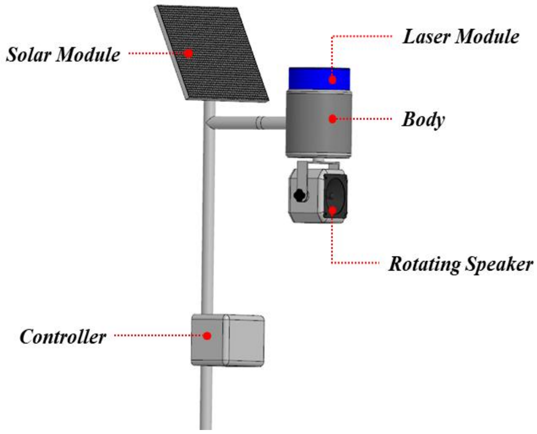


Fig. 2 Modeling of Bird repellent system

Fig. 2 shows the configuration of the improved bird deterrent system.

2.2.1 Light Source and Rotating Speaker Unit

The most important factor for enhancing the effect of deterring harmful birds is avoiding the learning effect of birds. For this purpose, it is important to implement deterrent methods of various patterns, whether visual or auditory. Because the improved bird deterrent system can reproduce sound at various angles through speaker rotation, it can generate sounds with a wider variety of patterns than the conventional fixed-type deterrent system.

The laser module comprises four 5-mW laser elements installed in the top portion of the deterrent system at an angle of 90°, and this module is designed to generate various visual patterns through a combination of control over the revolutions per minute (RPM) of rotation and that over the laser blinking frequency in the module. The deterrent system houses two motors in its body, and each of these motors independently controls the speaker and the laser module. Slip rings are configured on the top and bottom portions of the system to resolve the wire tangling issue that can occur due to rotation. Moreover, the speaker specifications have been revised to expand the deterrence area of the conventional bird deterrent system. The improved speaker system has superior capacity, output frequency, and sound pressure characteristics than those of the conventional speaker system, and the former is also suitable for outdoor use due to the implementation of waterproofing. Table 2 compares the speaker specifications of the conventional and improved bird deterrent systems.

2.2.2 Power Unit

In the power unit of the improved bird deterrent system, a PV module has been included so that users need not replace the system battery. The specifications of the PV module include 18 V and single crystal structure and those of the internal battery include 12V and 10.2 AH. When fully charged, this battery can power the system for about 3 days based on the current control cycle in the absence of power generation from the PV module.

Table 2 Comparison of speaker specifications

Parameters	Existing	Improve
Power	10 W	20 W
Frequency	~ 7 kHz	~ 10 kHz
SPL (Sound Pressure level)	94 dB/w/m	96 dB/w/m
Image		

2.2.3 Control Unit

The controller of the improved bird deterrent system, as shown in Fig. 3, is configured to control the speaker sound source, speaker direction and cycle, laser blinking frequency and speaker rotation RPM, and emission cycle, respectively. The speaker rotation angle is designed to randomly rotate within 360° in 10° increments, and the rotation and sound-generation cycle are programmed to randomly occur in 5-min increments within a range of 50–60 min. Because the rotation angle and cycle can vary depending on the installation environment, the values can be defined by users. The laser module is configured to operate for 20 s per operation, and the rotation RPM and blinking frequency per operation are implemented to be randomly generated.

3. Experimental Results and Discussion

3.1 Evaluation of Deterrent Sound Characteristics

The characteristics of the deterrent sounds of the conventional and improved bird deterrent systems were evaluated in terms of distance and direction.

According to the arbitration cases of the National Environmental Dispute Resolution Commission, the sound exposure criteria for ornamental birds is 50 dB(A), while the criteria for the effect of deterrent sound is 70 dB(A) for actual farmhouses with an open environment in all directions considering the scattering effect of sound. We determined the deterrence area of the deterrent sounds by measuring the distance to the reference decibel in all directions and calculating the accordingly based on the decibel measurement information along each speaker direction and distance. Fig. 4 shows a schematic diagram of the measurement method for evaluating the characteristics of the deterrent sounds. With the same sound source, Fig. 5 shows the sound pressure levels in decibels of the conventional and improved deterrent systems for each distance and direction. The measurements were performed in an ordinary orchard, where other sounds, such as natural wind noise and automobile sounds, were also present.

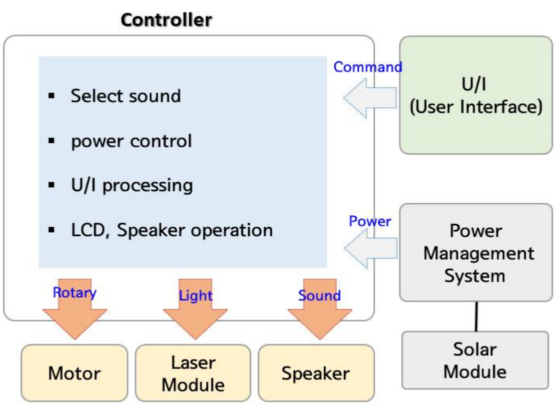


Fig. 3 Block diagram of repeller controller

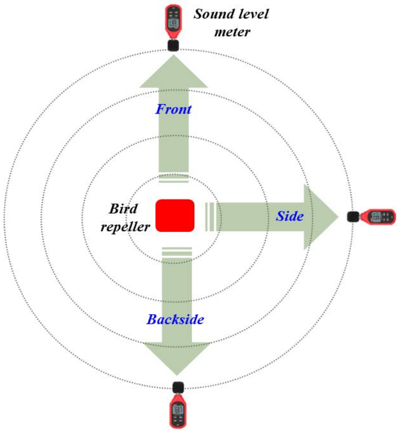
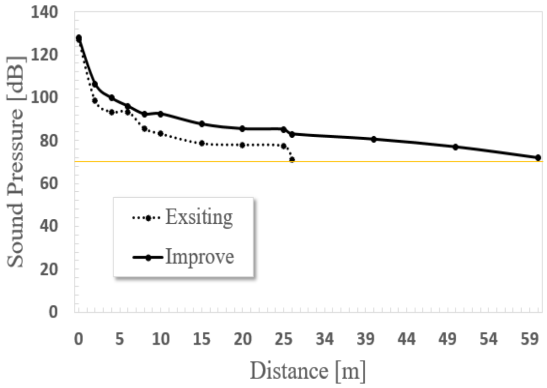


Fig. 4 An example of decibel measurement by distance and direction

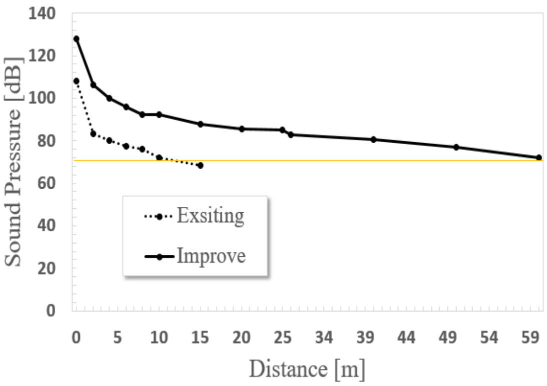
According to the measurement results, the sound pressure level of the sound source along the side and rear directions with respect to that along the front direction at 0 m was determined as 19–35 dB(A) in the products using the conventional system. The sound pressure also continuously decreased as the distance from the sound source increased, and it was approximately 71.1 dB(A) at 30 m along the front direction. By contrast, in the improved deterrent system that incorporated with enhanced sound pressure level of the speaker and rotating speaker, the overall sound pressure level of the speaker increased by 10 dB(A). Furthermore, because the speaker rotated 360°, its sound pressure characteristics were the same in all directions. The sound pressure level measured at a distance of 60 m was 71.8dB(A), which confirmed that the sound transmission distance approximately doubled compared to that of the conventional deterrent system.

Fig. 6 shows the deterrence areas of the conventional and improved deterrent systems based on the measured sound pressure characteristics.

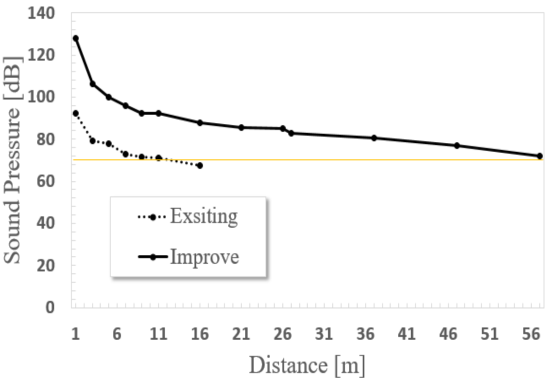
In case of the improved deterrent system, the deterrence area was defined by connecting the points in all directions in a form of a circle, and its value was calculated as the area of the circle, which yielded a deterrence area of approximately 11,304 m^2(approximately 3,419)



(a) Front Direction

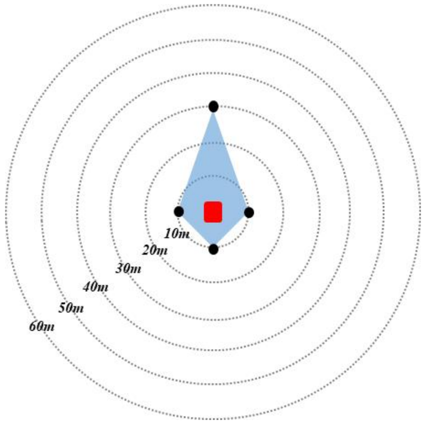


(b) Side Direction

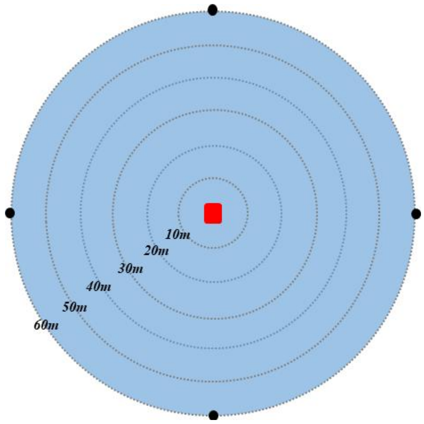


(c) Back-side Direction

Fig. 5 Decibel measurement by distance and direction



(a) Existing repeller



(b) Improve repeller

Fig. 6 repelled area of existing and improve repeller

3.2 System Evaluation in Fruit Tree Farms

The improved bird deterrent system was installed on a cherry farm with severe bird damage to verify its deterrence effect. Two hundred 5-year-old cherry trees were considered in our experiment. After setting the trees for which no deterrent system was installed last year as the non-treatment group and the trees for which the deterrent system was installed this year as the treatment group, the effect of the proposed system was investigated by comparing the damages in each year. According to the evaluation results, last year's non-treatment group exhibited a damage rate of 3.25%, which translated

Fig. 7 Performance evaluation of harmful bird repeller System

Table 3 Evaluation result in orchard environment

Parameter	Before installation	After installation
Amount of damaged apple	54 kg	9 kg

into a loss of approximately 65 kg from the total cherry production 2,000 kg. By contrast, the treatment group this year exhibited a damage rate of 0.35%, which translated into a loss of approximately 7 kg from the total cherry production of 2,000 kg. This result suggests an 89.2% or higher reduction in fruit tree damage post installation of the deterrent system, thus verifying the deterrent effect of the bird deterrent system. Fig. 7 shows the improved bird deterrent system installed in the cherry farm, and Table 2 summarizes the extents of damage to the fruit trees before and after installation of the bird deterrent system.

4. Conclusion

In this study, the authors designed a bird deterrent system with increased speaker sound pressure and a rotating speaker to enhance the deterrent effect of the conventional acoustic (adversarial sounds) bird deterrent system and evaluated the deterrent effect of the improved system. The improvement in speaker sound pressure was verified by the improvement in sound effect distance from approximately 30 m in the conventional design to a maximum of 60 m based on 70 dB(A), and the rotating structure improved directionality from coverage only in the forward direction to coverage in all directions without directionality, thereby increasing the deterrence area of the deterrent system. In future studies, we will work on avoiding the learning effect of birds by generating deterrent sounds by using a combination of artificial intelligence and acoustic pattern diversification.

Acknowledgment

This work has supported by Korea Institute of Planning and Evaluation for Technology in Food, Agriculture, Forestry(IPET) through Agro and Livestock Products Safety, Flow Management Technology Development Program, Smart Plant Farming Industry Technology Development Program, Advanced Production Technology Development Program, funded by Ministry of Agriculture, Food and Rural Affairs (MAFRA) (118076-2, 118080- 2, 119083-1 and 317072-04).

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