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Insect Avoidance and Temptation System Design based on Light Emitting Diode

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***Abstract*—In this paper, we proposed an insect avoidance and temptation system based on LED(Light Emitting Diode) lighting. In order to prevent contamination due to insect penetration in the food distribution and storage stages, it is necessary to analyze the activity patterns of harmful insects according to food, space and season. In addition, there is a need for an IoT(Internet of Things)-based system that can be remotely monitored and controlled because it is difficult for an administrator to access at night or a remote place. Therefore, we designed the insect avoidance and temptation system based on LED lighting using IoT. In particular, in order to avoid and tempt harmful insects that occur differently depending on food, space, and season, the dynamic wavelength band is controlled by one LED light to control physical access to specific harmful insects. In order to find out the avoidance wavelength according to the harmful insects, we have developed a real-time LED lighting control technology that can produce various wavelengths in one LED light.**

***Keywords*—food storage, harmful insects, avoiding wavelength, LED lighting**

Introduction

Recently, the damage caused by the penetration of insects in the food distribution and storage stages. Various efforts are made to prevent the penetration of insects, but it is difficult to prevent harmful insects that occur differently depending on factors such as food, season and space. In addition, in the case of night or remote places, it is difficult to prevent the access of harmful insects because the manager is difficult to access. Therefore, it is necessary to analyze the activity patterns of harmful insects that occur differently according to food, space, season, etc. and to find out the repelling wavelength of each harmful insect. By using eco-friendly LED lighting, we try to prevent harmful insects from penetrating by generating wavelengths of harmful insects. LED lighting is designed to control blue (450nm), green (525nm), yellow (590nm), and red (630nm) wavelengths to generate a wavelength that suits the situation. In addition, we developed a real-time LED lighting control technology that enables remote monitoring and control using IoT technology. By using this system, it can cope with harmful insects that occur differently depending on factors such as food, season, space, etc., and it is used to reduce the damage by preventing the penetration of insects in the food distribution and storage stage.

Design of System Architecture

A. LED lighting based insect avoidance, temptation system composition

Insect avoidance and temptation system based on LED lighting is to reduce the damage by preventing the penetration of insects in response to harmful insects that occur differently depending on factors such as food, season and space. Combine IoT technology for use in places where administrators have difficulty accessing, such as at night or in remote locations. The system consists of LED lights that can generate various wavelengths, controllers for lighting and dimming individual lights, and IoT modules for remote control.

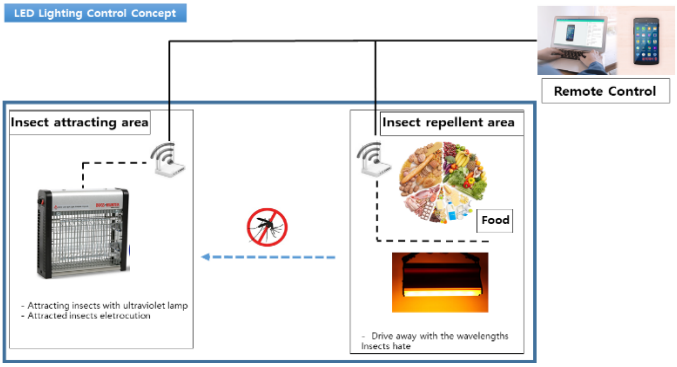

Fig. 1. LED lighting-based insect avoidance, temptation system configuration

B. LED lighting design and configuration

Unlike conventional products on the market, LED lighting has been developed to generate wavelengths in one tube. There are four types of wavelengths: blue(450nm), green(525nm), yellow(590nm), and red(630nm). Taiwan EPISTAR LED chip is used. LED lighting module configuration is as follows.

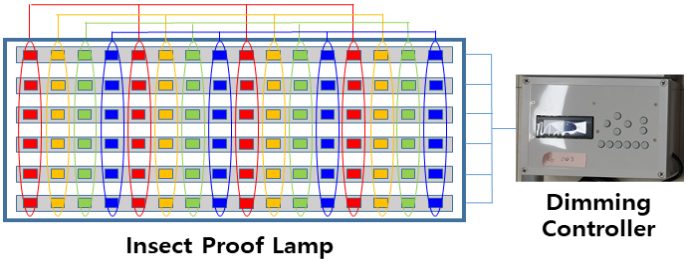

Fig. 2. LED lighting module configuration

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As shown in the picture, the blue, green, yellow, and red chips are alternately composed of 8 LEDs each, consisting of 32 LED chips. It is connected to internal circuit by color so that each wavelength can be turned on. The individual lighting of each wavelength is as follows and it is also possible to light at the same time.

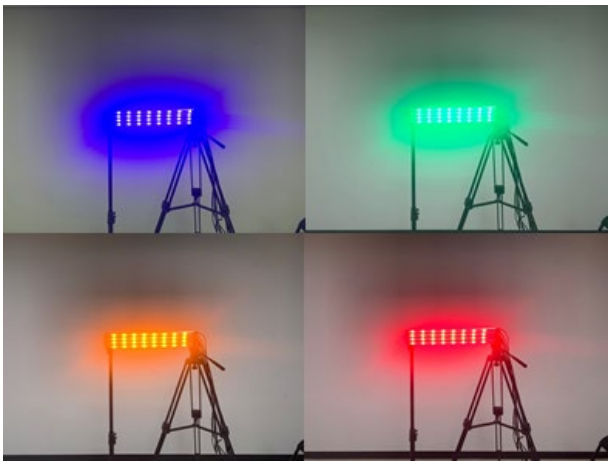

Fig. 3. LED lighting module configuration

Dimming controller can be used to adjust the brightness of each wavelength. Dimming methods include pulse width modulation dimming, frequency modulation dimming, and constant current control [1]. In this paper, the brightness is controlled by the constant current method. The dimming controller consists of a buck / boost converter for adjusting the brightness in a constant current method and MCU(Micro Controller Unit) for controlling it. The dimming value is expressed in the range of 0 to 100. Both the direct control and the program can be used for remote control.

C. Control program

Incorporating IoT technology for remote control of the above system. Control program includes MFC(Microsoft Foundation Class)-based window program and web program. We used a module called nodeMCU to communicate with WIFI(wireless fidelity) and used port forwarding technology and DDNS(Dynamic Domain Name Service) technology for remote access from external networks. The figure below is an MFC-based Windows program.

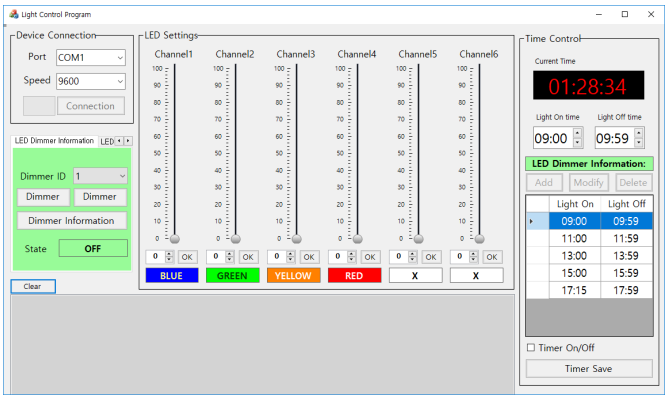

Fig. 4. Control program

In the control program, each wavelength can be lit individually and the brightness can be adjusted. Also, this program can be set the desired time and wavelength to schedule the lighting of different wavelengths for different time zones. Web programs are under development and a complete IoT system can be established as users can access and control them from anywhere on the Internet without the need for a separate program. RS485 wired communication was used to communicate with the dimming controller. ① Communication speed : 9600bps ②Data length : 8 Bit ③ Stop Bit : 1Stop Bit ④Parity : None Parity ⑤ Communication mode : Binary Mode Packet configuration for data transmission is as follows.

TABLE I. DATA TRANSMISSION PACKET CONFIGURATION

HEADER		IDENTIFIER		DATA		TAIL		CRC
DLE	STX	OPCODE	LENGTH	ID	DATA	DLE	ETX	CRC
0	1	2	3	4/5/6/7+N		8+N	9+N	10/11+N

CATEGORY		CONTENTS	VALUE	TYPE	SIZE
HEADER	DLE	Data Link Escape	0x10	Byte	1
	STX	Start Transmission	0x02	Byte	1
IDENTIFIER	OPCODE	Command Message Type	Variable	Byte	1
	LENGTH	DATA Section Length	Variable	Byte	1
DATA	ID	Slave ID Number	Variable	Byte	2
	DATA	Data by Command Type	Variable	Byte	N
TAIL	DLE	Data Link Escape	0x10	Byte	1
	ETX	End Transmission	0x03	Byte	1
CRC	CRC	CRC-16 Error Check	Variable	Byte	2

The data packet structure is largely divided into a header, an identification unit, data, and a tail unit CRC(Cyclic Redundancy Checksum) unit. The header part informs the start of data transmission. Two bytes are sent to 0x10 and 0x02 to indicate the start, and the identifier gives the command type and data length. The data unit transmits the ID and command data of the connected dimming controller, and the TAIL unit notifies the end of 2 bytes with 0x10 and 0x03. Finally, the CRC value for error checking is transmitted. CRC value is CRC-16-IBM standard and calculates OPCODE, LENGTH, DATA part. CRC polynum is 8005 (HEX) and Initial value is ffff (HEX) to check the error.

D. Insect repellent basic experiment

This is a basic experiment to check the degree of gathering of insects according to the wavelength of LED lighting. Four kinds of wavelengths were blue green yellow red and lit for 30 minutes, respectively, to confirm the degree of gathering of insects. The results of the experiment were eight in blue, three in green, two in yellow and two in red. The insect repellent phenomenon was observed at the yellow wavelength. Studies on the insect repelling wavelength include studies on the repellent characteristics of larvae and adults of Spodoptera exigua and Spodoptera litura [2]. In the future, it is necessary to study the avoidance characteristics of many insect type.

Fig. 5. Outdoor insect repellent basic experiment

CONCLUSION

Most food vaults and warehouses are located in rare places, making it difficult for managers to respond promptly, monitor or manage them. The insect avoidance and temptation system based on LED lighting presented in this paper can help to solve this problem. In addition, it can be customized to control various environmental conditions such as fine dust control, ventilation control, temperature and humidity control fumigation control in conjunction with IoT technology. The proposed technology can reduce manpower input and damage to various environments within complex distribution structures.

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