A lighting system using multiple climate sensors in conjunction with remote monitoring network

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Abstract

To overcome the drawbacks of dust contamination, uncontrollable exposure time, and rain spoilage when using open sun drying in food preservation, a remote monitoring/controlling lighting system using multiple climate sensors is presented. The system can remotely monitor/control a lighting system using multiple climate sensors. It is convenient for a food-processing factory such as in the drying of the plum preserves and mullet roe and in the wind drying of the rice noodles. The user can preset the time for lighting via the server port/client port. Four climate sensors (thermal detector, wind speed detector, luxmeter, and rain detector) are adopted to detect environmental conditions. According to environmental conditions (temperature, wind speed, lighting, and rain), the system will send out/retrieve clothing and food. An IPCAM is used for image-monitoring via the server port and client port. Consequently, the device saves manpower, is user friendly, and is convenient.

Subject Classification: (2010) 93A99.
Keywords: Automation, Drying, Food, Remote, Shining, Solar.

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1. Introduction

Grabowski et al. indicated that in order to increase food security, over twenty of the world’s unpreserved crops are dried [1]. Belessiotis and Delyannis reported that drying, a simple process of removing excessive water, has been widely used with agricultural and industrial products [2]. Aliyu et al. pointed out that solar energy, in viewing its seeming unbounded prospective, is the most hopeful renewable energy sources [3]. In recent decade, efforts in developing solar dryers used agriculturally have been performed in developed countries. Chikaire et al. reported that solar energy used in agriculture has many aids: lowering cost, growing self-sufficiency, and decreasing pollution [4].

There are various food drying methods. Wankhade et al. indicated that the selection of aeration methods relays on various parameters including the sort of products, accessibility of dryers, price of drying, energy consumption, and feature of dried products [5]. For the necessity of energy saving, two kinds of solar drying methods (solar air drying methods and open sun drying methods) have been widely used. Gupta et al. [6] showed that costs of processing are usually high when using a solar air drying method to control the conditions of temperature, humidity, and airflow. Conversely, open sun drying, drying under open sunlight directly, can be more economic and cost less without using extra electrical power.

As investigated by Itodo et al. [7], because the electrical supply is not stable and the fee of relic petroleum is very high, farmers in Nigeria are still utilizing the customary practice of an exposed sun dehydrating method for aeration crops. According to Ashish et al. [8], because of its simplicity and low cost, open sun drying is more popular and is commonly used in tropical nations for dehydrating agricultural crops and food packages. However, this method suffers from disadvantages, including dust contamination, long time exposure, attacks by animals, spoilage due to rain, etc. [9, 10, 11, 12].

In order to overcome the drawbacks of dust contamination, uncontrollable exposure time, and rain spoilage, a remote monitoring/controlling lighting system using multiple climate sensors is presented. Here, the food located inside a transparent case can avoid an attack by animals. To avoid dust contamination due to strong wind, the system is equipped with a wind speed sensor and will retrieve objects when wind speed is increased. Also, to improve the lighting quality, the system, which has a thermal sensor and lux meter, will be initiated under higher temperatures and lux. Moreover, to prevent rain spoilage, the automatic
CONJUNCTION WITH REMOTE MONITORING NETWORK

object lighting system equipped with a rain detector will retrieve the food when it rains. To sum up, the system is convenient for food-processing such as drying plum preserves and mullet roe and wind drying rice noodles. It is also convenient for drying clothing (ultraviolet rays sterilization) for people who are on duty in the daytime. Furthermore, considering the safety factors of an automatic lighting system, an IPCAM used for image-monitoring on site via the server port and client port is established. Consequently, the device saves manpower, is user friendly, and convenient.

2. Remote Monitoring/Controlling Lighting Structure

The remote monitoring/controlling lighting structure shown in Fig. 1 is composed of four environmental detectors (a thermal sensor, a wind speed sensor, a luxmeter, and a rain detector), one location identification sensor (an infrared sensor), a conveyer device, an actuator (motor), a microcontroller, a server PC/client PC, and an IPCAM. Each part is organized by microcontrollers – PIC18F4520 displayed in Fig. 2. Four environmental detecting sensors (a thermal sensor, a wind speed sensor, a luxmeter, and a rain detector) connected to the microcontroller will detect environmental parameters and turn back the information to server PC (the near part) through the blue tooth protocol and display them on the server PC’s interface using VB6.0. In order to identify the object’s location, an infrared sensor installed onto the conveyer and connected to the microcontroller is adopted. A motor will be triggered by micro-controller to clockwise/counter-clockwise rotate to send out object for lighting or to retrieve the object back home. Two operation modes (automation mode and hand mode) are designed into the interface. The process of the object lighting system using a manipulation function (hand mode) is displayed in Fig. 3. Both Fig. 3(a) and Fig. 3(b) indicate that the environmental data detected by the sensors will be sent to the server and shown on the interface after the server (near part) is connected to the micro-controller. As shown in Fig. 3(c), in order to keep the object in a good lighting situation, the setting of three thresholds (environmental temperature, environmental lux, and wind speed) is necessary. As illustrated in Fig. 3(d) and Fig. 3(e), the position initialization of the object before the lighting process is started in advance. Fig. 3(f) and Fig. 3(g) indicate that a manipulation test initiated by clicking the hand mode on the interface is executed. With this, the object can be sent out for lighting by hand manipulation.
A demonstration of automatic object lighting is shown in Fig. 4. As illustrated in Figs. 4 (a)-(e), three thresholds of environmental parameters are preset. In addition, the object position is initialized before the lighting process starts up. As revealed in Fig. 4 (g), the automatic object lighting is initiated by clicking the “auto mode” on the interface. Sufficient environmental temperature, sufficient lux from sun light, and minimal wind speed will result in optimum lighting. Therefore, before the object can be sent for lighting, all the environmental conditions specified by the thresholds need to be satisfied. As illustrated in Figs. 4 (h)-(i), because environmental parameters (temperature and lux) sufficiently reach the minimal levels and the wind speed is below the maximal value, the object is then sent for lighting. The algorithm for automatic object lighting is demonstrated in Fig. 5. Fig. 5 reveals that the lighting process is terminated and the object will be retrieved home using the motor and the infrared sensor if temperature and lux are too low, the wind speed too high, and it is raining. For convenience, an alternative selection initiated by presetting the lighting time on the interface is also established. The operation of object lighting using a timer function (auto mode) shown in Fig. 6 reveals that the time of object lighting is preset on the interface. As illustrated in Figs. 6(b)-(d), the object lighting process is initiated by the starting time. Similarly, as shown in Figs. 6(e)-(f), the object lighting process is terminated with the ending time. The algorithm for object lighting using time settings is displayed in Fig. 7. As depicted in Fig. 7, the object will be sent out for lighting during this time period. However, the lighting will also be terminated if it rains or if the environmental conditions (environmental temperature, lux, and wind speed) do not satisfy the specified thresholds.

3. Human and Machine Interface Device

The server (near port) will connect to the micro controller (the equipment part) thru the RS-232 as well as the BT (blue tooth). Here, the microcontroller will be linked to the actuators (DC motors) and the environmental sensors (thermal detector, luxmeter, wind speed sensor, rain detector, and infrared sensor). As illustrated in Fig. 1, the IPCAM which is linked to the movable AP router will transmit the captured appearance to the server. To remotely manipulate the motor, detect environmental parameters, and visually monitor the object lighting site, the server’s interface written by VB is required. Fig. 8 reveals that the interface for the server (near port) and the client (remote port) is initiated.
4. System Communication Design

To reach the remote control, a TCP/IP model for near port and remote port is implemented and performed via “Winsock” component. The interactive message transmission for the near port and the remote port is displayed in Fig. 9 [13, 14].

(1) To listen at server (the near part): The server is on the status “To Listen” when the server is waiting to be linked by the client (remote part). One WINSOCK component in the near part will is only used to answer back to a remote part. A WINSOCK component is specified to be in charge of a “To Listen” mission during the communication process.

(2) To connect at client (the remote part): A linking demand will be sent through the WINSOCK component. The WINSOCK component can consign a specified port at the near part.

(3) To receive at server (the near part): The near part will get a connection request command emitted from the remote part while the remote part submits an invitation of “To Connect.” In addition, the near part will accept the linking demanded from the remote part by means of the “To Accept” command thru a new “WINSOCK.”

(4) To send information from client (the remote part): The remote part will submit information to the near part thru the “To SendData” while the internet of the near part is already connected to the remote part.

(5) To receive information at server (the near part): The near part will receive the information’s arrival signal emitted from the remote part when the remote part sends information to the near part. Also, the near part can obtain the information from the remote part by utilizing the “To GetData” command.

(6) To receive information at client (the remote part): The remote part can generate and recognize the data arrival while the near part sends information to the remote part. Similarly, the remote part can get the information thru “To GetData” command.

(7) To terminate the communication: The link is terminated by ticking the “To Close” command if remote communication is not necessary.
5. Results and Discussion

The remote monitoring/controlling lighting system has been presented. Four environmental detecting sensors (a thermal sensor, a wind speed sensor, a luxmeter, and a rain detector) used to detect environmental parameters are connected to the microcontroller. Communication between the near port and the microcontroller is established using a blue tooth protocol. The environmental parameters will be detected online and turned back to the interface of the near port. Two operation modes (auto mode and hand mode) are inside the interface. Manipulating the object light by a hand mode function is illustrated in Fig. 3. In addition, the automatic object lighting process is also shown in Fig. 4. For convenience, the routine object lighting also uses a time selecting function. The process is demonstrated in Fig. 6. To keep the object in good lighting, three kinds of thresholds (environmental temperature, environmental lux, and wind speed) are preset before the lighting process is started.

A site test for the lighting process that terminates because of a sudden rain is shown in Figs. 10(a)-(c). As illustrated in Fig. 10(a), the rain is detected and turned to the near port interface. The near port will then submit a command to the microcontroller to terminate the lighting process by triggering the motor to retrieve the object home, Figs. 10(b) and 10(c). Similarly, as shown in Figs. 11(a)-(c), the lighting process will also be terminated when current wind speed is higher than the specified threshold value. Likewise, as illustrated in Figs. 12(a)-(c), the lighting process will be stopped when the environmental lux is lower than the specified lux threshold. The site test of the lighting process at lower environmental temperatures is also depicted in Figs. 13(a)-(c). Subsequently, as shown in Figs. 13(a)-(c), the lighting process will end when the environmental temperature is lower than the specified temperature threshold. To assure lighting, an auxiliary visual monitoring on site using an IPCAM is also established along with online monitoring on the near port / remote port control ports. As a result, a model of the remote observing/controlling lighting system is constructed and shown in Fig. 14.

6. Conclusion

It has been shown that a wireless monitoring/controlling lighting system can be distantly observed and operated during the object lighting process. The near port is wirelessly linked to the micro controller via both the RS-232 and BT. The micro-controller links to the rain detector, the wind
speed sensor, the thermal sensor, the luxmeter, the infrared sensor, and the motor. Concerning economizing manpower, the system is designed to automatically shine light on objects. In addition, a time designation for object lighting is also available in the system by inputting the desired time period into the interface. In order to avoid spoilage due to rain, the system will bring the object home by triggering the motor when rain is detected. Also, to avoid dust contamination due to strong wind, the object will be brought home via the system when the wind speed is higher than the specified threshold value. Moreover, to improve lighting, the lighting process will be initiated if the weather parameters (temperature and sunshine) are beneficial. To assure safety during the automatic lighting process, visual monitoring on site using an IPCAM is established.

Consequently, a wireless monitoring/controlling lighting system has been demonstrated.

![Diagram](image1)

(a) A food drying application

![Diagram](image2)

(b) A cloth lighting application

Figure 1
The remote monitoring/controlling lighting system.
Figure 2
The diagram of the microcontroller – PIC18F4520.

(a) Start up communication between the server port and the microcontroller.

(b) Current wind speed, temperature, and lux detected by the sensors are fed back to the interface.

(c) Setting the thresholds for the parameters (wind speed, temperature, and lux).

(d) Initial position of the object.

Contd...
(e) Current position status is “in home.”

(f) Select “hand mode” to send the object out of home for lighting by the manipulation function.

(g) Infrared sensor and motor are running, both the mode and position status are exhibited, object is under lighting.

Figure 3

The operation process of object lighting using the manipulation function (hand mode).
(a) Start up communication between the server port and the microcontroller.

(b) Current wind speed, temperature, and lux detected by the sensors are fed back to the interface.

(c) Setting the thresholds for the parameters (wind speed, temperature, and lux).

(d) Initialized position of the object.

(e) Current position status is “in home.”

(f) Select “auto mode” to send the object out of home for lighting by the automation function.

Contd...
(g) The operation mode under the automation function.

(h) The lux condition (outside) increases but does not reach the threshold of 300 lux (the minimal value for object lighting).

(i) The lux condition (outside) of 301 reaches the threshold of 300 lux and initiates the lighting process.

(j) Infrared sensor and motor are ON, position status is displayed; the object is under lighting.

Figure 4
The operation process of object lighting using automation (auto mode).
Figure 5
The algorithm for automatic object lighting.

(a) Setting the timer.

(b) Starting and the object lighting process are initiated.

(c) Object is under lighting.

(d) Lighting process continues.

Contd...
The ending of the lighting process.

Object is sent back home (lighting process is terminated).

Figure 6
The operation process of the object lighting using a timer function (auto mode).

Figure 7
The algorithm of the object lighting using a time setting.
(a) Client PC.  
(b) Server PC.

Figure 8
The interface of the server PC and the client PC.

Figure 9
The corresponding communication diagram interface between the server PC and the client PC.

(a) Rain detected by the rain detector.  
(b) An object retrieving process is initialed by triggering the motor and the infrared sensor.

Contd...
(c) Object is retrieved at home.

**Figure 10**
The lighting process is terminated due to an environmental factor (sudden rain).

(a) Wind speed exceeds the threshold of wind speed.  
(b) An object retrieving process is initiated by triggering the motor and the infrared sensor.

(c) Object is retrieved at home.

**Figure 11**
The lighting process is terminated due to an environmental factor (strong wind speed).
(a) Environmental lux is lower than the threshold of lux.  
(b) An object retrieving process is initialed by triggering the motor and the infrared sensor.

Figure 12
The lighting process is terminated due to an environmental factor (insufficient lux from sun light).

(a) Environmental temperature is lower than the threshold of the temperature.  
(b) An object retrieving process is initialed by triggering the motor and the infrared sensor.

Contd...
(c) Object is retrieved at home

Figure 13
The lighting process is terminated due to an environmental factor (insufficient temperature).

Figure 14
The prototype of a remote monitoring/controlling lighting system.

References


