Smart Automatic Vertical Blind Based on Iot

Ki-Young Lee, Jeong-Jin Kang, Sung-Jai Choi, Gyoo-Seok Choi, Han-Chun Song, Eun-Young Kang

Abstract:With the recent development of the IT industry, IoT technologies and markets are developing rapidly in various aspects of the interior design market. Such developments make the life of people more convenient, safer and more efficient. The purpose of this study is to utilize IoT technologies on blinds to automatically control the blinds using a smartphone for more convenient and efficient use of blinds. The smart auto blind uses Arduino Uno as well as UV sensors and a DC motor to operate the blinds automatically. In addition, it was designed and implemented to operate with a smartphone by connecting with application using a Bluetooth, and solar batteries are used in the blind.

Index Terms:Internet of Things; Vertical Blind;Arduino; Smart Phone; Ultraviolet-ray Sensor

I. INTRODUCTION

Due to recent trends of pursuing convenience and safety in interior design, IoT is commonly combined with interior design [1]. Furthermore, as it is possible to configure eco-friendly and energy-conserving interior design by using IoT, various types of smart interior design are currently being developed. Accordingly, this study aims at developing a smart auto blind that combines blinds, which are essential in interior design, with IoT so that the blinds can move automatically by user according to desired time and quantity of UV rays instead of manually adjusting the blinds that takes time from busy schedules. In addition, detailed adjustments to the blinds can be managed through smartphone application [2,3].

In this study, modules that smart auto blind using Arduino utilizes a DC motor, UV sensor and Bluetooth module that can connect the blinds to Arduino for providing convenience for users to freely operate the blinds according to UV rays through application. Moreover, it is combined with a solar battery for eco-friendly and energy-saving use of blinds. These blinds can be used anywhere such as homes and offices, and the convenience of smart auto blinds is needed even more in environments such as hospitals, nursing homes, senior welfare centers, etc[4,5].

It can also be used in other areas where sunlight is an important element such as botanical gardens and orchards. Therefore, this study designed and implemented a smart auto blind that can be effectively used in terms of convenience and energy, in light of the smart interior age that integrates IoT, as well as in facilities such as hospitals, welfare centers, botanical gardens, and orchards.

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Ki-Young Lee, *Department of Medical IT, Eulji University, Seongnam, Korea*

Jeong-Jin Kang, *Department of Information and Communication, Dong Seoul University, Seongnam, Korea*

Sung-Jai Choi, *Departmentof Electronic Engineering, Gachon University, Seongnam, Korea*

Gyoo-Seok Choi,*Department of Computer Science, Chungwoon University, Incheon, Korea*

Han-Chun Song, *Department of Information & Communication Engineering, Seoil University, Seoul, Korea*

Eun-Young Kang, *Department of Computer Software Engineering, DongyangMirae University, Seoul, Korea*

II. RELATED WORKS

A . IoT(Internet of Things)

IoT refers to technologies and environments in which data can be exchanged in real time via internet by attaching sensors on objects [6]. IoT connects everything including people, devices, spaces and data through a network to connect people with things as well as between things to exchange data and it refers to an ecosystem in which reciprocal communication is possible anywhere and anytime. It refers to the ultra-connected internet in an ultra-connected revolutionary age which is expected to follow the industrial revolution and information revolution. IoT technologies are new revolutionary technologies that can construct such ultra-connected internet environments and a new ecosystem that offers such services to people.

B. Arduino

Arduino is a tool that creates interactive objects and digital devices that can detect and control the physical world. It refers to an open source computing platform and software development environment based on a simple microcontroller board. Arduino receives input values from various switches and sensors and controls output with electronic devices such as LEDs and motors to create objects that can interact with the environment. For example, various products such as simple robots, thermo-hygrometers, motion sensors, music and sound devices, smart home configurations, children's toys and robotic education programs can be developed based on Arduino. Furthermore, Arduino discloses its circuitry as an open-source so that anyone can make and modify their own boards [7].

C.Ultraviolet-ray Sensor

UV thoron and photomultiplier detect UV rays. UV thoron is a structure connected to a DC power through series resistance by having positive and negative poles face each other inside of a container made with materials in which UV passes such as UV transmitting glass. When an outside negative UV ray is radiated, photoelectrons are emitted through the photoelectric effect on the cathodic surface [8].

D.Solar Battery

Device that converts the light energy of sunlight into electric energy. It uses a P-type semiconductor and N-type semiconductor and when light is irradiated, the internal charge moves to create a potential difference between the P pole and N pole. When light is irradiated on solar batteries, an electron and positive hole are generated inside. The generated charges move to the P pole and N pole and through this action, a potential difference (photoelectromotive force) is created between the P pole and N pole and by connecting a load on the solar battery at this time, an electric current starts to flow. This is called the photovoltaic effect [9].

III. SYSTEM DESIGN AND IMPLEMENTATION

A. System Design

This study uses an Arduino board. The smart auto blind in this study was produced using UV ray sensors that measure UV values at different times, a DC motor for an automatic operation of the blind, an auxiliary battery that uses solar batteries to provide power to the auto blind, and a Bluetooth module for linking Arduino with application. Such smart auto blind proposes an environment that can automatically adjust thelength and angle of the blind according to the environment set in Android. The system blueprints for this is as shown in Figure 1.

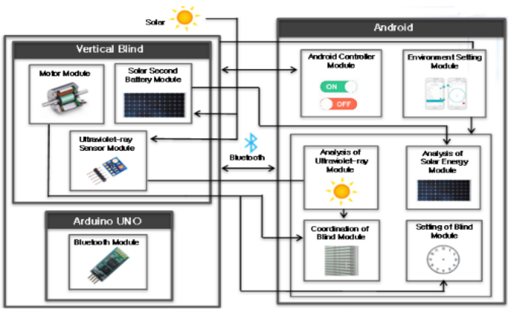

Fig. 1System Architecture

The blueprints of Figure 1 is comprised of UV sensor module that measures UV rays, a DC motor that operates the blinds, solar battery for collecting power for the blinds, and communication module links Bluetooth and Arduino, and an application module that finely adjusts the blinds. In the case of solar batteries, a solar controller and closed maintenance-free battery for utilizing sunlight were used to produce solar cell auxiliary battery and this solar cell auxiliary battery was attached to the blind. For the application, the communication with Android is made using Bluetooth to adjust the blind length. Adjustment of the blind is automatic using a DC motor when it goes over or under the designated UV ray value by using a DC motor and UV sensor. Through this, it is possible for the user to use the blind more conveniently and efficiently.

B. System Implementation

The system in this study was implemented in Windows 10 64-bit operating system and Arduino Sketch was used to measure UV values. Also, MIT App Inventor was used to configure Android application.

```
Power ON
// Start Condition : Closed Blind
Repeat:
UV Sensor detect Solar heat;
UV Sensor measure UV Value;
if(UV Value <10){
 Opened-blind (3);
}
if(UV Value >=16){
 Closed-blind (3);
}
Function 1 :
Opened-blind (int Sec){
// DC Motor Counter Clock wise -3 Sec
};

Closed-blind (int Sec){
// DC Motor Clock wise -3 Sec
};
```

Fig. 2UV Sensor-DC Motor Flow

When the power is turned on, UV sensor-DC motor module shown in Figure 2 detects sunlight using UV sensor according to the implemented algorithm and then measures UV ray value. Afterwards, direction of the DC motor is adjusted according to the measured UV values. As shown in Function 1 of Figure 2, the DC motor direction operates counterclockwise for three seconds when opening the blinds and clockwise for three seconds when closing the blinds. When designing the blind according to the above preconditions, it is as shown below. Once the blind starts to operate, DC motor first runs for three seconds clockwise to close the blind. This state where the blind is closed is the default settings of the blind angles. Once the default configuration of the blinds is completed, UV sensors connected to the blinds measure UV values. As shown in Function 1 of Repeat, the measured UV value is over 16, the DC motor runs for 3 seconds counterclockwise, and stops the operation until UV value is measured at less than 10. When the UV value is later measured to be less than 10, the DC motor runs for three seconds clockwise and stops the operation until measured UV value exceeds 16. The blinds operate repeatedly according to such algorithm [10].

```
Screen 1 is Initialize;
Bluetooth is Connected;
if(Connected Bluetooth){
  CharacterEncoding 'Bluetooth is Connected"
};
else(Unconnected Bluetooth){
  CharacterEncoding 'Bluetooth is Unconnected"
};
Repeat:
Push 'UP' Button;
  Blind is going up;
  // DC Motor Counter Clock wise
Push 'Down' Button;
  Blind is going down;
  // DC Motor Clock wise
```

Fig. 3 Application DriveFlow

The process of the algorithm in Figure 3 is as shown below. First, when Screen 1 is connected to Android, Bluetooth is connected. Once Bluetooth is connected, a message will appear as “Bluetooth is Connected.” If Bluetooth is not connected, a message will appear as “Bluetooth is Unconnected.” Once Bluetooth is connected and “UP” button on the application screen is pressed, the blind connected to DC motor will go up. Here, the DC motor will run counterclockwise for the duration that the button is pressed. By pressing “DOWN” button, the raised blind will be lowered and the DC motor will run clockwise for the duration that the button is pressed.

C. Implementation Results

Figure 4 uses and configures Arduino to adjust the length and angle of the blind using UV sensor and DC motor. The environment for measuring UV values was configured to measure UV rays in the two environments; sunlight and the building’s internal LEDs. Accordingly, DC motor rotates in the direction (clockwise/counterclockwise) as set according to UV values of the given environment.

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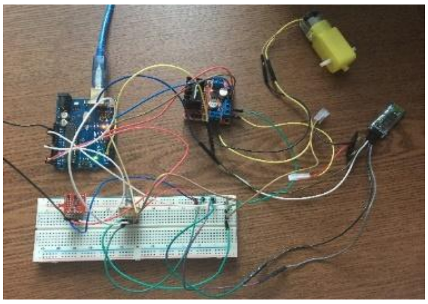

Fig. 4 System Implementation Results 1

Arduino was connected to Android using a Bluetooth module. The length of the blind can be adjusted using the button on the application. The image of the application is as shown in Figure 5.

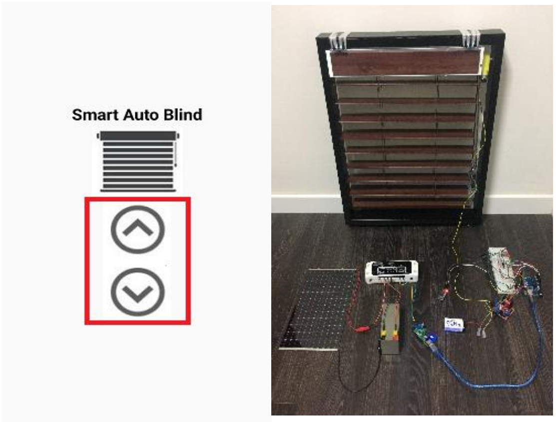

Fig. 5System Implementation Results 2

Figure 6 is an auxiliary battery using film-type solar battery. It was produced using a solar battery (15.4V) and solar controller (12V6A), closed maintenance-free battery (12V1.3Ah), and DC-DC converter. The solar cell auxiliary battery enables more efficient use of blinds while conserving energy. By using solar cell auxiliary battery, it does not require cable connection between laptop and Arduino to receive power and it reduces unnecessary battery usage. As such, an automatic operation of the blind is possible through a solar cell auxiliary battery [11,12].

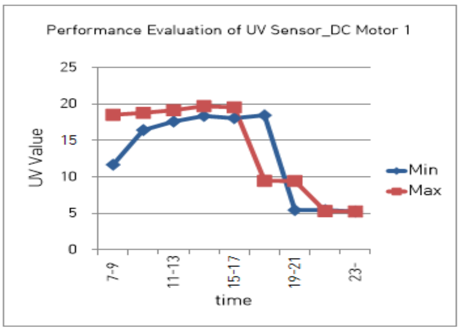

Fig. 6 System Implementation Results 3

IV. PERFORMANCE EVALUATION AND RESULTS

The performance evaluation of the smart auto blind was drafted based on UV values measured in UV sensors per timeframe. The environment for measuring UV values was selected as inside the building which is the environment that the blind is commonly used. Also, the environment in which UV values are deduced is sunlight and internal LED environment of the building. In Table 1 for the environment with given sunlight, UV values were measuredper timeframe to observe the direction in which the DC motor rotates. The time in which UV values were measured was from 7 a.m. to 11 p.m. As shown in Table 1, the UV value until the sun was completely up stayed at about 11 and 12, but when the sun rose completely, the UV value was measured to be in excess of 17. Once the sun starts to drop, the value that was at about 17 rapidly dropped to below 11. Likewise, the DC motor runs clockwise or counterclockwise based on UV values measured according to the designed algorithm.

Table 1Performance Evaluation of UV Sensor DC

Time	UV Value		DC motor
	Min	Max	Direction
7 - 9	11.65	18.49	CW
9 - 11	16.40	18.76	CW
11 - 13	17.57	19.12	CW
13 - 15	18.33	19.69	CW
15 - 17	18.02	19.51	CW
17 - 19	18.43	9.44	CW/CCW
19 - 21	5.43	9.42	CCW
21 - 23	5.43	5.29	CCW
23 -	5.23	5.24	CCW

Figure 7 is a visualized graph of Table 1. It shows the maximum and minimum values of UV rays per timeframe for measuring UV. The vertical axis of the graph represents UV value and the horizontal axis shows the time at which UV was measured. Figure 7 simply visualizes the maximum and minimum values of UV rays measured according to timebuilding where daylight blue and warm white LEDs are located The environmental conditions in which the DC motor's rotational directions were observed are when the LEDs were turned on and turned off [13]. Test results showed that UV value measured in the environment when LED light was turned on was approximately 18 and had little differences when the color was daylight blue and warm white. The measured differences are as shown in Table 2. In the environment where LED lamp was turned off, UV value was measured in an environment where the sun was completely set and in an environment where there was almost no light and in complete darkness. As a result, it was found that the measured UV value was at about 5 and had little difference during daylight blue and warm white.

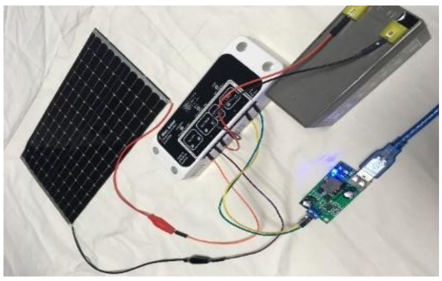

Fig. 7Performance Evaluation of UV Sensor_DC Motor

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Table 2Performance Evaluation of UV Sensor_DC Motor

Switch	UV Value				DC motor Direction
	Daylight Blue LED		Warm White LED		
	Min	Max	Min	Max	
ON	18.18	18.25	18.03	18.14	CW
OFF	5.68	9.94	5.68	9.94	CCW

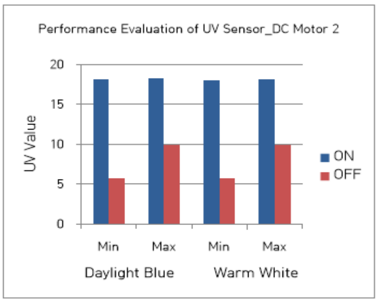

Fig. 8Performance Evaluation of UV Sensor_DC Motor

Figure 8 is a graph that visualizes Table 2. It measured the minimum and maximum values of UV rays measured through UV sensors when the daylight blue LED and warm white LED were turned on and off in the building. The vertical axis of the graph shows measured UV values and the horizontal axis shows the minimum and maximum values of each LED

V. CONCLUSION

In this study, the smart auto blind was designed and implemented using Arduino Uno, UV sensors, DC motor, Bluetooth module, and solar batteries. The smart auto blind uses a UV sensor and DC motor to make it more convenient and effective than manual blinds in this system. The smart auto blind is a measure suggested to use blinds more conveniently in everyday life. Furthermore, the smart auto blind would be even more efficiently used in environments such as hospitals, nursing homes, welfare centers, and botanical gardens.

Currently, the smart auto blind was implemented to work using a motor to utilize simple UV measuring methods. However, more UV sensors will be used and various motors will be compared and analyzed to conduct research on more stable and improved blinds.

REFERENCES

1. Ki-Young Lee, Seok-Hyon Kim, Seung-Bin Cho, So-Jung Lee, Don-Hee Lee, Jeong-Jin Kang, Sung Jai Choi, Toshiro Minami, “A Study on the Target Location Alerts System Using Arduino”, Advanced and Applied Convergence Letters 10(AACL 10), ISAAC 2017, pp. 15-20, 2017.
2. Seong-Won Min, Jong-Yong Lee, Kye-Dong Jung, “Design of Coordinator Based on Android for Data Collection in Body Sensor Network“, *International Journal of Advanced Culture Technology(IJACT),* Vol. 5, No. 2, pp. 98-105, 2017.
3. Se-Hwan Park, Jong-Kyu Park, “ IoT Industry & Security Technology Trends“, *International Journal of Advanced Smart Convergence(IJASC),*Vol. 5, No. 3, pp. 27-31, 2016.
4. Danupon Kumpanya, Sattarpoom Thaiparnat, “ Real Time Electrical Energy Computing Tool“, *International Journal of Advanced Culture Technology(IJACT),* Vol. 3, No. 1, pp. 113-119, 2015.
5. Sang-Yule Choi, “ The Development of Intelligent Direct Load Control System“, *International Journal of Advanced Smart Convergence(IJASC),*Vol. 4, No. 2, pp. 103-108, 2015.
6. https://terms.naver.com/entry.nhn?docId=3577301&cid=59088&categoryId=59096
7. https://terms.naver.com/entry.nhn?docId=2835912&cid=40942&categoryId=32828
8. https://terms.naver.com/entry.nhn?docId=657138&cid=42338&categoryId=42338
9. Admas, Sintayehu. "Review of Biological Impacts of Genetically Engineered Crops and Neonicotinoid Treated Seed Use on Staten Island." The International Journal of Biotechnology 5. 4 (2016): 62-68.
10. Yun-Hyung Lee, Myung-Ok So, “GA-based parameter identification of DC motors”, *Journal of Korean Society of Marine Engineering,* Vol. 38, No. 6, pp. 716~722, 2014.
11. Woo-Hee Lee, Mi-Young Lee, Jun-Ha Lee, Hoong-Joo Lee, “Calculation of capacity of solar cell and battery for stable solar system design”, *Journal of the Korea Academia-Industrial cooperation Society,* Vol. 6, No. 5, pp. 396-400, 2005.
12. Shoewu, O., N. O. Salau, A. O. Ogunlewe, and L. I. Oborkhale. "Path Loss Measurement and Modeling for Lagos State GSM Environments." Review of Computer Engineering Research 3. 4 (2016): 69-84.
13. Haseeb, M., Abidin, I. S. Z., Hye, Q. M. A., & Hartani, N. H. (2018). The Impact of Renewable Energy on Economic Well-Being of Malaysia: Fresh Evidence from Auto Regressive Distributed Lag Bound Testing Approach. *International Journal of Energy Economics and Policy, 9*(1), 269-275.
14. Hyun-Ju Youm, In-Tea Kim, An-Seop Choi, “A Study on the Perception of the Brightness Change according to Daylight Responsive LED Dimming Systems and Venetian Blind”, *Journal of KIIEE(The Korean Institute of Illuminating and Electrical Installation Engineers),* Vol. 27, NO. 12, pp. 44-53, Dec. 2013.

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