Study on New Display System using Windmill and Light Emitting Diode

Kazuto YUKITA, Tomohiko ICHIKAWA, Tadashi HOSOE, Yasuyuki GOTO, Katsuhiro ICHIYANAGI
Department of Electrical and Electronics Engineering
Aichi Institute of Technology
1247 Yagusa Yachigusa Toyota AICHI 470-0392
JAPAN

Abstract: - This paper proposes a new system which displays the image by wind power generation and the light emitting diode. The proposed system is a system which introduces Light Emitting Diode into the braid of a windmill, and displays an image by the afterimage. The Light Emitting Diodes (LED) are three colors. These three colors are red, blue, and green. Thereby, an image can be displayed in a color. This system can change the contents of a display by communicating. Then, two kinds of wind-power systems examined this system. One is a horizontal-axis type windmill. Another one is a perpendicular axis type windmill. A horizontal-axis type is the display by 2 dimensions. Also, a perpendicular axis type is a 2-dimensional display too. As this reason, a display of a horizontal axis is the windward or the lee. A display of a perpendicular axis becomes in the direction of 360 degrees. The validity of the proposed system was proved using the small wind-power system.

Key-Words: - Wind generator system, Blade, Light emitting diode, After image phenomena

1 Introduction

The movement that restricts the exhausts of carbon dioxide and the SF6 gas, etc, strengthens in the government and the private organization. Third Conference of Parties to the UN [United Nations] Framework Convention on Climate Change (COP3) came into effect as one of such the movements. Japan has to reduce 12% at the time of now between 2008 and 2012. Therefore, an effort more than before is necessary for the government and the private organization, etc. Especially, new energy has the expectation for the environmental protection. The introduction target of the photovoltaic generation and wind power generation is 4.82 million kW, and wind power generation is three million kW by 2010. The photovoltaic generation and the wind power generation have been installed as not only power generation but also the symbol. Various methods are proposed to utilize the system of usefulness for wind power generation. Ordinary family's crime prevention light, uses such as the street light and the electric bulletin boards are reported using in the micro type wind power generation. This paper proposes the wind power generation system that can display the image. It aims at effective use for the entire system. The proposal system displays the image on the rotation space of the braid by introducing light emitting diode (LED) into the windmill braid, and using the afterimage phenomenon by the light of LED rotating the braid. The examination was carried out using the horizontal axis type wind power generation and the vertical axis type wind power generation in respect of the system which proposed this report.

2 Windmill braid that buried LED

This paper examined the horizontal axis type windmill and the vertical axis type wind windmill. First of all, the horizontal axis type used the wind power generation of two kinds marketed in general. The braid assumed Earozen of Britain LVM Co. to a first model, and produced the type that introduced red LED of 16 per one braid (197mm in the length of the braid). The other braid assumed AIR403 of Southwest WindPower Co. to a second model, and produced the type that introduced three kinds of LEDs: Red, Blue, and Green, of 32 per one braid (525mm in the length of the braid). Earozen was compared with AIR403. At this time, Earozen braid is shown in Fig.1(a), and AIR403 braid is shown in Fig.1(b).

Next, the braid of the vertical axis type windmill buries LED of three colors per one braid (2000mm in the length of the braid). Each color LED buries 192 pieces and 576 pieces in total. Fig.2 shows the braid of the vertical axis type. Displaying the image by the color by using it by three primary colors of light by using red, green, blue LED like this braid becomes possible.


(a)LED16 (b)LED96

Fig.1. Horizontal-axis type braid

Fig.2. Vertical-axis type braid

3 Display system that used braid

The rotational speed of the braid was always changeable by the wind. Therefore, the system that designs the rotation of the braid constantly can recognize the image only at the time of the set rotational speed. And, the problem that the strain is generated in displaying image occurs, when the rotational frequency changes. Then, it is necessary to control the speed at which the image is displayed according to the rotational speed of the braid to solve this problem. The proposal system measures the rotational speed, and is controlling the blinking speed of LED buried under the braid. The composition of the control part is shown in Fig.3. The rotational speed is measured because of infrared rays or light as shown in Fig.3, and LED blinks per rotation controlled blinking time. Concretely, the image projected on the rotation space in the system that produces it controls one rotation by dividing into 256 for the horizontal axis type, and it controls by dividing into 512 for the vertical axis type.

Therefore, it becomes possible that the image without the strain is displayed, even if the rotational frequency of the blade fluctuates. Next, it is necessary to control LED individually to do the blinking control, and the I/O port of LED corresponding to the number of LED is needed. Therefore, the vertical axis type braid used this time should control 192 ports per color. The controller makes to a large scale, and power consumption increases corresponding to this, too. In addition, the number corresponding to LED is needed in the control line of LED. Then, this system uses the dynamic lighting control method. LED can be controlled by minimum number of I/O ports to use this lighting control method.

Actually, the system made two LED a couple, and was able to decrease a control line that was necessary by 96 to 22 by using this lighting control method. As for the problem of this control method, quantities of light of LED darken few, and overall in order current of the same value as the static lighting control method.

Therefore, order current value is decided in consideration of the LED characteristic compared with the pulse width and Dudi, and the brightness of LED is adjusted. Displaying the image in colors adjusts color strength. However, the produced circuit cannot control the current value that flows to individual LED because it miniaturized as much as possible to install it in wind power generation. Therefore, it has been achieved to adjust the ratio (It is blinking numerical of LED concretely) that red, green, and blue light to display the image by the color without using color strength. Fig.4 shows the circuit actually produced. Only one color of one braid is controlled by one electronic circuit board as shown in Fig.4.

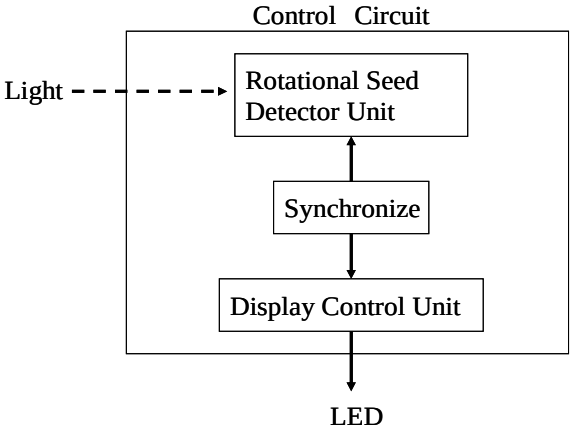


Fig.3. Concept of a control system

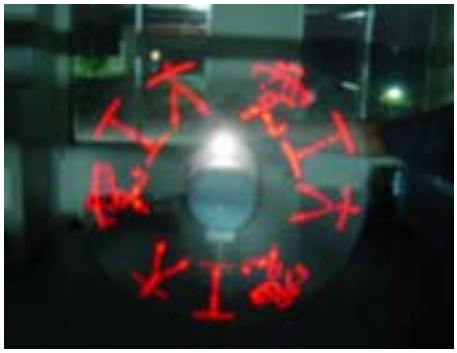
Fig.4. Control circuit

4 Examination of image by afterimage phenomenon

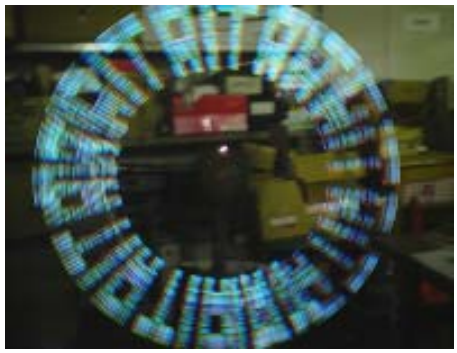
The system that proposes it in this paper is introduced into the wind power generation system, The image to which the horizontal axis type windmill and the vertical axis type windmill were displayed was examined. First of all, the horizontal axis type windmill that buried 16 LED's was examined. Moreover, Blades of Earozen are three. At this time, the displayed image is shown in Fig.5(a). Fig.5(a) is an image at velocity of the wind 4m/s and the rotational speed 100 rpm. The displayed character displayed three characters by the abbreviation name of Aichi Institute of Technology. The character can be confirmed to three places on the rotation side of the braid. It is possible that this system recognizes the character even if the wind velocity lowers to 2m/s. Next, when the 96 LED's was buried, the image was examined. Wind power generation used AIR403 being sold by the Suthwest WindPower Co. Blades of AIR403 are three in this case. The displayed image is shown in Fig.5(b). It is time when Fig.5(b) displayed the image at 5m/s in the velocity of the wind. The display character displayed three characters of “AIT”. The color of buried three colors LED is not clear. However, it is understood to be displayed in white comparatively because it blinks to three simultaneous colors. The vertical axis type windmill that buried 576 LED's was examined. This windmill is gyro-mill type which has four braids. Fig.6 shows the vertical axis type windmill.

Fig.6(a) is taking a picture of the whole of the windmill. Fig.6(b) is the one when the image is displayed by the rotation. If it is animation at the animation level, it is possible to display it beautifully. An image of the horizontal axis type windmill was compared with an image of the vertical axis type windmill. The image side becomes the windward or leeward, and the horizontal axis type windmill is a constant direction the image side, it is a display on two dimension. Moreover, it is understood that the image shrinks toward the rotation center. Because the image side is 360 degrees, the vertical axis type windmill can confirm the image from any district. For this, the image display of three dimensions becomes the rotation space of the braid with possible. In addition, the proposal system amplifies not resistance to the power supply part of LED but the current and is using current regulative diode (CRD). Therefore, the voltage descent is caused for the braid becomes long. The difference of the brightness of quantities of light shortage and lighting by this is improved.

Fig.7 shows the current that flows to LED of the braid when CRD is used and when resistance is used. Moreover, Fig.8 show in the case to use resistance and the case to use CRD. In comparison with these, it is about 10mA in CRD while the supply current of LED is about 3mA when resistance is used. It is understood to be improved by using CRD when comparing it by the image. It is understood that the proposal system that uses the windmill braid and LED is excellent from these results.



(a)LED16



(b)LED96

Fig.5. Display with horizontal axis windmill

(a) Whole appendix photograph

(b) Image display example

Fig.6. Display with vertical axis windmill

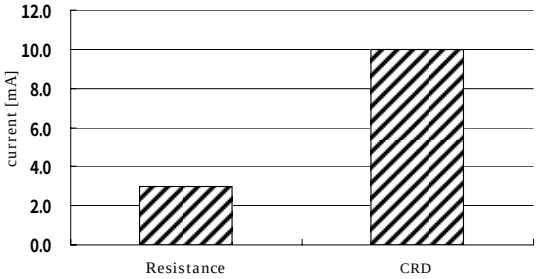
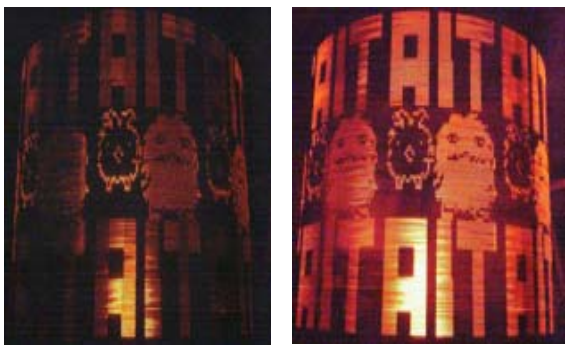


Fig.7. Current that flows to LED



(a) (b)

Fig.8. Comparison of images

5 Image data communications system

The proposal system can change the display image according to a radio communication. Fig.9 shows the composition chart of the radio communication system. This proposal system does serial communications by the baud rate 9600bps, and has simplified the data change with a wireless device. Fig.10 shows the circuit actually used. If the wireless is communicated, the windmill need not be stopped when writing of the image data is changed, and data need not be rewritten detaching the microcomputer. The image is actually rewritten according to a radio communication while the windmill is rotating. First of all, the image data of the bitmap format shown in Fig.11(a) is prepared. The subtractive color process by the dithering is used and this image is divided into three color image as shown in this figure (b), (c), and (d). The purpose of the reason divided into three colors is to control each color in case of the purpose is not to be able to control color strength.

Next, the image divided into three colors is bitting converted respectively. Then, the image can be changed by rewriting data that converts the bit by using serial communications of the personal computer as the data of the display system. It actually changed as shown in Fig.11(b) from Fig.11(a). Moreover, it is necessary to rewrite each color when communicating with this system.

This paper is made to be able to be communicated only with the display system of the specified color by giving the address data of each color to the display system beforehand as a method of rewriting each color. Therefore, the image data of other colors doesn't change because it specifies the address data when writing is changed. As a result, each color can be rewritten.

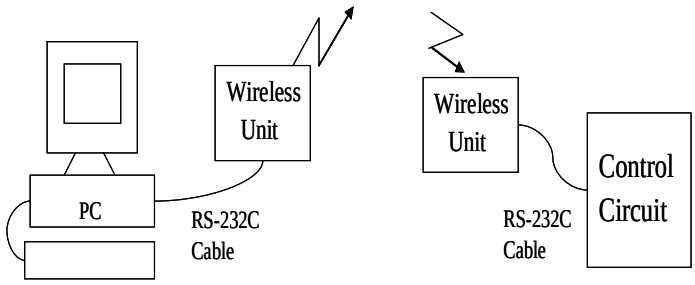


Fig.9. Configuration of radio communication system

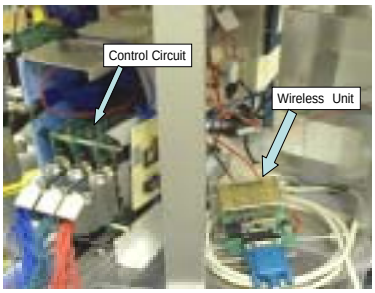


Fig.10. Communication control unit

(a) Original image (b) Red image

(c) Green image (d) Bleu image

Fig.11. Image data

(a)Before (b)After

Fig.12. Image of the case
using communication system

6 Field test

The field was tested by using the high Bullitt type power generating system of the vertical axis type windmill system and the photovoltaic generation system to actually confirm the effectiveness of the proposal system. This system is a complete, independent type power supply where the commercial power is not used. First of all, 200W generator and the electric assistance motor are installed in the wind power generation system. This electric assistance motor is using it to reduce the start torque when the pinwheel is rotated in case of the purpose is to display the image. Next, the photovoltaic generation system is installed six photovoltaic generation of 80W per piece, and can generate electricity about 480W in total. Battery, the data logger, the control system, and the radio communication system, etc. are set up in the panel. Table 1 shows the specification. The electric power used with this system uses the one to have generated electricity with the photovoltaic generation system and the wind power generation system. The electric power used is consumed with the LED display system and the control system, etc. Moreover, it remotely observes it by using the Web camera and the cellular phone for metrological data, the image, and the amount etc. of power generation. The field was actually tested. There was operation in 185 days from March 25, 2005 to September 25, 2005. Fig.14 shows the operation results of this system.

Fig.13. Installation case

Table.1. Specification of the system

windmill	blade configuration	gyromill (vertical axis windmill)
	number of blade	6
generator	rated output	200W
	number of phase	3
	number of poles	32
display	number of LED	576(1blade)
	arithmetic processing unit	microcomputer (16bit)
auxiliary power	solar battery panel	480W
	secondary battery	300Ah

System the numbers of operating days were 169 days per 185 days. The system stop days were the 16th. As for the cause of the stop, the one by an artificial factor and the one by a natural factor are enumerated. First of all, the stop by an artificial factor was a stop by the mis-operation of the system program. Next, it is time when stop by a natural factor stopped the system by the heavy rain, the thunder, the typhoon, and the wind, etc. A slight breakdown has neither blinking nor lighting by rain. Therefore, the image becomes indistinct, and the image might become hard to see. However, if it is a slight breakdown, the influence was able to be a little, and to usually operate the system in the operation of the system. As a result of operation, First of all, there were a lot of stops of the field test start due to the system breakdown. The system stop was almost lost when becoming the latter half. Next, there are a lot of stops by a natural factor from July in September. Especially, there are a lot of stops by the typhoon. It is time of the rainy season that a lot of slight breakdowns are and rain is multi in June. Therefore, there were neither a lot of blinking nor lighting LED. As a result of the field test, the image was able to be confirmed only within the range of the aim level of LED in daytime even if there was a rotation enough for the windmill. The image in the color was able to be confirmed at nighttime as shown in Fig.15. The image was able to be confirmed even by a distance about 40m away.

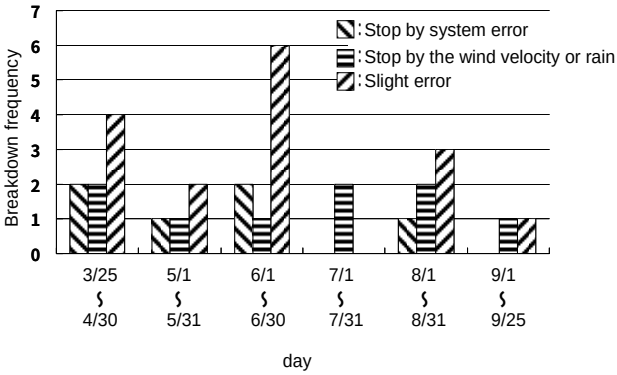


Fig.14. Operation results of system

Fig.15. Example of display in the outdoors

7 Conclusion

This paper proposed the image system that used the windmill braid and the light emitting diode as one of the effective use for the small wind power generation system expected an increase in the future. This proposal system is a system that displays the picture and the image on the rotation space by setting up LED in the windmill braid, and using the afterimage phenomenon of light. It examined it respectively by using the horizontal axis type windmill and the vertical axis type windmill to confirm the effectiveness of this system. In addition, the vertical axis type windmill executed the field test. As a result, the horizontal axis type windmill is 2 dimensions the image side, and can confirm the image only in the direction of constancy. The vertical axis type windmill was able to confirm the image from any

district 360 degree. As a result of the field test, the image was able to be confirmed only within the range of the aim level of LED in daytime. However, the image in the color was able to be confirmed at nighttime. The system is scheduled to be improved to display the image even in daytime in the future.

References:

[1]I.Ushiyama : ”Base of the wind energy”, Ohmsha.co, pp175-185, (2005) (in Japanese)

[2] A.Kawahara, S.Mitsuishi, K.Sagara, and K.Seki : “An Application of Straight Blade Non-Articulated Vertical Axis Wind Turbine Generation Systems”, Proc. of the 27th Wind Energy Symposium, pp.323-326 (2005-11)(in Japanese)

[3] K.Kawakami, and K.Seki : “A Study about Generation Characteristic of Wind-photovoltaic Hybrid Generation Streetlight for Dairy Farm Village”, Proc. of the 27th Wind Energy Symposium, pp.212-214 (2005-11)(in Japanese)

[4] M.Shin, K.Yukita, Y.Goto, K.Ichiyanagi, and T.Kusakabe : “Presentation of the Wind Power Generator System as a Monument”, Power & Energy 2002, Power & Energy Society Annual Conference,No.509 (2002-7)(in Japanese)

[5] M.Shin, T.Kamiya, K.Yukita, Y.Goto, K.Ichiyanagi, and T.Kusakabe : “Display System by Light Emitter Embedding Windmill Blade”, IEEJ Trans. PE, Vol.123, No.7, pp.894-895 (2003-7)