出國報告（出國類別：國際會議）

參加 (ICNSE 2015)國際研討會並發表論文

服務機關：國立虎尾科技大學

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派赴國家：日本(京都)

出國期間：104 年 5 月 07 日至 5 月 12 日

報告日期：104 年 7 月 2 日

摘要

此次參加第四屆 International Congress on Natural Sciences and Engineering(ICNSE 2015)，是 IEEE 國際性的學術研討會，這次會議在日本的京都舉辦，舉辦時間爲 104 年 5 月 7 日起三天，主要行程包括教學演講、論文發表討論與參訪。本次的論文發表題目是吊扇的節能與噪音改善，能源的節約受到全世界的矚目，節能家電因爲新電力電子技術的發展，逐步變得重要起來，在國際會議論文裏有許多新的能源構想，值得參與。這次會議算是多元性的會議，會議包含電子、電機、機械、化學、通訊...等不同的議題，在論文發表過程中可以聽到不同角度的問題，並且與不同領域的研究人員相互討論與意見交換。參加國際研討會除了可與國際學者交流外，也增加國際觀。

目次

（一）目的:包括原定計畫目標、主題、緣起、預期效益或欲達成事項。

此次出國是參加第四屆 ICNSE 2015 是 IEEE 國際性的學術研討會，會議舉辦時間爲 104 年 5 月 7 日起三天，主要行程包括教學演講、論文發表討論與參訪，會議在日本的京都主辦，舉辦地點是 KRP(Japan, Kyoto Research Park) ，論文發表題目是吊扇的節能與噪音改善，能源的節約受到全世界的矚目，在日本，政府積極的推動節能電器，設法提高電器使用效率與電能管理，對改善電廠興建有很好績效。因此，節能家電因爲新電力電子技術的發展，逐步變得重要起來，國際會議論文裏，有許多新的能源構想，值得參與。

（二）過程:依計畫執行經過，包括出國期間行程、參訪單位及訪問過程。

ICNSE 2015 國際研討會，會議舉辦時間爲 104 年 5 月 7 日起至 5 月 9 日共 3 天，會議中除了專題演講外，共有 5 個會議討論主題，涵蓋工業相關的種多領域:

1.ICNSE : International Congress on Natural Sciences and Engineering

2.ICCBES: International Congress on Chemical, Biological and Environmental Sciences

3.ICSSAM: International Conference on Social Science and Management

4.ISEPSS: International Symposium on Education, Psychology and Social Sciences

5.ICEAI: International Congress on Engineering and Information

這次會議算是多元性的會議，會議包含電子、電機、機械、化學、通訊...等不同的議題，論文發表中可以聽到不同角度的問題，同時，也可以給予不同領域研究的人員建議。例如，機械在精密切割時，馬達的振動關係重要，我們可以討論從電機角度去改善機械問題，這是他們沒有涉入的議題，會議使不同領域的研究人員一起討論，形成有趣又有意思的一面。

參加第四屆 ICNSE 2015 論文發表題目是吊扇的節能與噪音改善，能源的節約受到全世界的矚目，在日本，政府積極的推動節能電器，提高電器使用效率與電能管理，有很好績效。研討會與國際學者交流外，並與中外友人共同討論有關節能家電與電力電子控制器之發展趨勢，新能源與替代能源主題是與論文目標相似，探討節能與電能轉換許多不同方法與技術，足以爲參考。

論文發表議程如圖 1 所示，論文編號爲 ICNSE1402，圖 2 是 ICNSE 2015 國際學術會議會場與台灣同行教授留影，圖 3 是 ICNSE 2015 國際學術會議會場，圖 4 是 ICNSE 2015 國際學術會議論文研討會議片段。發表論文全文在附錄中。

（三）心得及建議事項：包括與出國主題相關之具體建議事項，建議參採或借鏡處。

1.KRP 這是很現代化的研究中心與討論訓練的場所，非常適合會議、訓練，更可以設有餐廳的位置，這是現代化都市中的很好科技與土地的應用方式，值得現在發展中的台灣城市參考。

2.能源的節約受到全世界的矚目，如果能夠在家庭電器上節省 20%耗電的改善，在台灣就能減少核電廠或是燃煤空氣汙染的機組。在日本，政府積極的推動節能電器，設法提高電器使用效率與電能管理，有很好績效。因此，節能家電因爲新電力電子技術的發展，逐步的重要，國際會議論文裏，有許多新的能源構想，值得注意發展。

3.參加國際研討會除了可與國際學者交流外，也增加國際觀去了解日本京都當地的發展、文化、特色及生活態度。

Poster Session (7)

Engineering / Industrial Engineering

Kyoto Research Park 4F **13:30-14:30** **Saturday, May 9**

ICNSE-1394

Shape and Composition Analysis of Carbon Black Recycled from Waste Tires

Dong-Su Kang | *Kumoh National Institute of Technology*

Sang-Min Lee | *Kumoh National Institute of Technology*

Seong-Moon Oh | *Kumoh National Institute of Technology*

Jae-Seung Roh | *Kumoh National Institute of Technology*

ICNSE-1396

Energy Band Gap Determination from Diffuse Reflectance Measurements of Synthesized Titanium Dioxide Nanotube Arrays Using the Anodisation Process

Waramon Langlar | *Srinakharinwirot University*

Areeya Aeimbhu | *Srinakharinwirot University*

ICNSE-1398

Exploring the Percentage of Suspected Femoroacetabular Impingement Patients by Radiographic Analysis in a Regional Hospital of Central Taiwan

Jian-Horng Chen | *Chung Shan Medical University*

Kai-Ling Chang | *Taichung Hospital, Ministry of Health and Welfare*

Chung-Liang Lai | *Taichung Hospital, Ministry of Health and Welfare*

ICNSE-1402

Reduction of Noise for Ceiling Fan

Jonq-Chin Hwang | *National Taiwan University of Science and Technology*

Chuan-Sheng Liu | *National Formosa University*

L. R. Chen | *National Changhua University of Education*

Chao-Ming Wu | *National Formosa University*

ICNSE-1413

Development of Audio Enhancement Algorithm in Reverberant Environments

Shyang-Jye Chang | *National Yunlin University of Science and Technology*

Hung-Wei Hsieh | *National Yunlin University of Science and Technology*

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圖 1. 論文發表議程

圖 2.ICNSE 2015 國際學術會議會場

圖 3.ICNSE 2015 國際學術會議會場

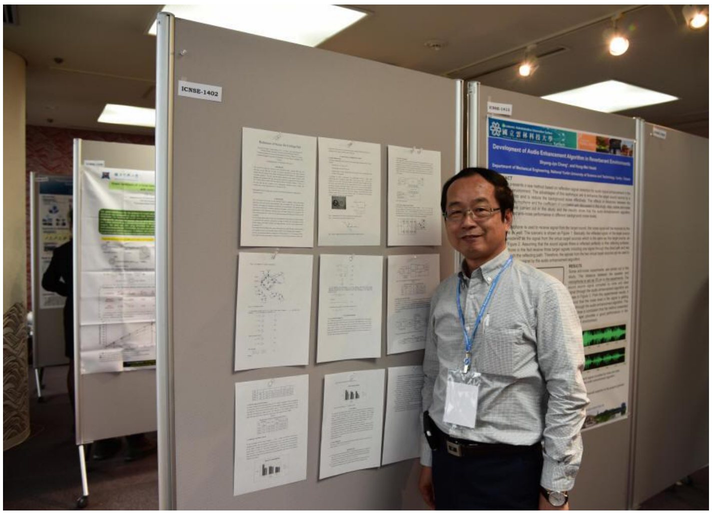

圖 4. ICNSE 2015 國際學術會議中

國際學術會議網址: *http://www.icnse.org/index.asp?id=52*

www.icnse.org

附錄 A：發表論文全文

ICNSE-1402
Reduction of Noise for Ceiling Fan

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ABSTRACT

The electrical ceiling fan, based on the induction motor, operate with very low efficiency on the high slip. In order to improve the efficiency and noise, inverter benefit with the unipolar Pulse Width Modulation (PWM) method is used under the two phase operation. The new type two-phase induction motor speed control is first designed and compared with the conventional method by using the two-phase theory. The voltage source inverter with four legs provides two phase voltages, v_a and v_b , to the main and the aux winding in the single-phase induction motor. Further, the rotation noise of the induction motor is reduced 10 dB.

Keyword: Electrical ceiling fan, inverter, Pulse Width Modulation, single-phase induction motor

1. Introduction

The conventional fan based on the induction motor is popular. Those split-phase induction motor are internal rotor machines. They are usually low-cost machines and operated on the high slip, therefore, the fan have poor performance. The speed control with very low efficiency is made by using the inductance or the resistor in series. The performance of the split-phase induction motor has been improved by using the 2-D finite element analysis [1]. However, the pulsating torque and efficient of the fan is still a problem.

For the energy conservation reason, the development of high efficiency electric motor is required for the electrical ceiling fan. In order to reduce the consumption of the electric energy, the PWM methods with high efficiency can be a good speed control for the fan [2-7]. The unipolar PWM methods have many advantages like high efficiency and less noise. In this paper, the new type two-phase speed control is first designed and compared with the conventional method by using the two-phase theory [2-7]. The energy will be saved when the same type motor is compared to the conventional induction motor fan. Further, the rotation noise of the induction motor is reduced 10 dB when the fan is operating in the unipolar of PWM control methods.

2. Control Theory of Single-Phase Motor

2.1 Basic Requirement

The basic requirement of the fan based on the single-phase induction motor is listed as follow：

Input Power : AC source 110V

Speed Range : 60 rpm to 200 rpm

Speed Change: At least 3 step(60rpm for low speed. 70rmp for mid speed, and 90 rpm for high speed)

According to above requirement, the single-phase induction motor with squirrel-cage rotor is design by using 8-pole 32-slot shown as fig.1. There are 16 single layer coils on the 16-slot for the main coils and the other 16 single layer coils for the aux coils and be split into two phases shown as in Fig. 2. In order to get the two-phases operating, the phase voltage on the aux coil in series with the capacitor has leading current and the phase voltage on the main coil become the lagging current. Fig. 3 shows the phase on the coils current and voltages. The pulsating torque of the induction motor always made the rotational noise. The efficient of the induction motor operated with high slip is still a problem.

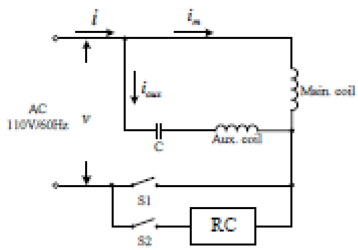

Fig. 1. Photograph of conventional single-phase induction motor

Fig. 2. Conventional single-phase induction motor

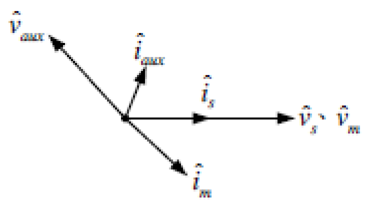

Fig. 3. Phase voltage and current on the single-phase induction motor

2.2 System Construction

The voltage source inverter provides the voltage with the sinusoidal wave form to the single-phase induction motor shown as in the Fig. 4. The speed can be changed by using the V/F control. Two-phase V/F control schematics, the unipolar PWM methods are used for the reduction of the harmonic distortion and the power consumption. The harmonic distortion on the unipolar PWM is much better than that on the bipolar PWM inverter in the same load. The rotation noise is also reduced when the harmonic is getting better.

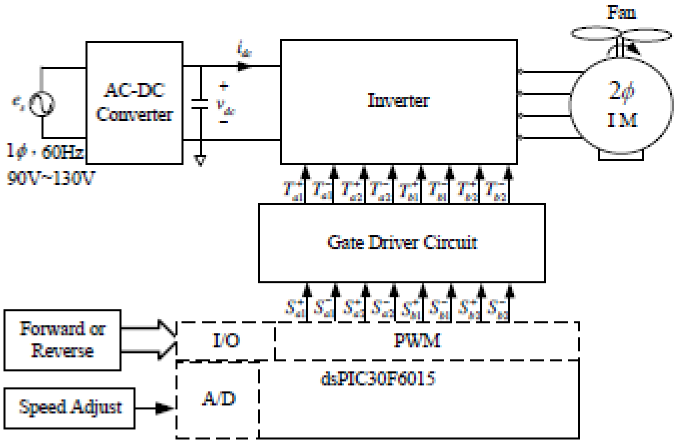

Fig. 4 System construction

2.3 Two Phase Voltage Control Method

The voltage source inverter provides two-phase voltages, v_a and v_b, to the main and the aux winding in the single-phase induction motor shown as in the Fig.5. The two-phase voltage, v_a and v_b, are the sinusoidal wave form with V/F speed control and separated into 90 degree shown as in the Fig.8. The benefit of two-phase control is the noise reduction, because it supplies the right angle to coils directly.

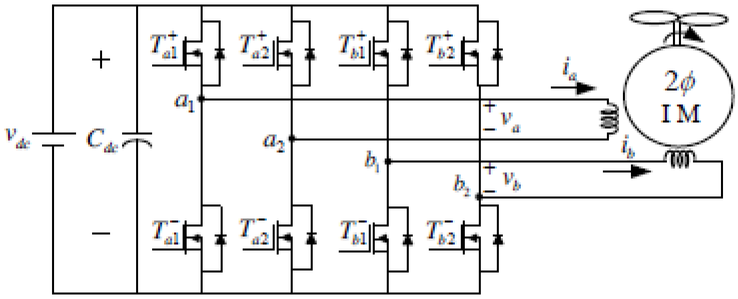

Fig. 5. Two-phase V/F control schematics

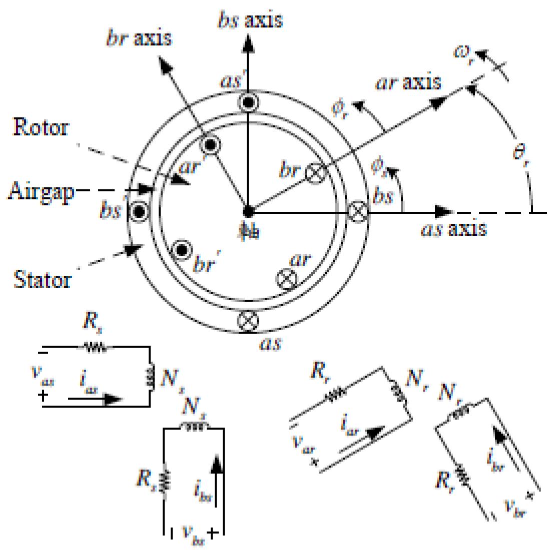

Fig. 6. Two-phase model

In two-phase model, shown as in Fig. 6, the stator voltage (v_{as} v_{bs}) and the rotor voltage (v_{ar} v_{br}) is expressed as equation 1..4:

$$v_{as} = R_s i_{as} + \frac{d}{dt}\lambda_{as} \quad (1)$$

$$v_{bs} = R_s i_{bs} + \frac{d}{dt}\lambda_{bs} \quad (2)$$

$$v_{ar} = R_r i_{ar} + \frac{d}{dt}\lambda_{ar} \quad (3)$$

$$v_{br} = R_r i_{br} + \frac{d}{dt}\lambda_{br} \quad (4)$$

Write in matrix form:

$$v_{abs} = R_s i_{abs} + \frac{d}{dt}\lambda_{abs} \quad (5)$$

$$v_{abr} = R_r i_{abr} + \frac{d}{dt}\lambda_{abr} \quad (6)$$

Flux linkage :

$$\begin{bmatrix} \lambda_{abs} \\ \lambda_{abr} \end{bmatrix} = \begin{bmatrix} \tilde{L}_s & \tilde{L}_{sr} \\ (\tilde{L}_{sr})^T & \tilde{L}_r \end{bmatrix} \begin{bmatrix} i_{abs} \\ i_{abr} \end{bmatrix} \quad (7)$$

Where

$$\tilde{L}_s = \begin{bmatrix} L_{ls} + L_{ms} & 0 \\ 0 & L_{ls} + L_{ms} \end{bmatrix} \quad (8)$$

$$\tilde{L}_r = \begin{bmatrix} L_{lr} + L_{mr} & 0 \\ 0 & L_{lr} + L_{mr} \end{bmatrix} \quad (9)$$

$$\tilde{L}_{sr} = L_{sr} \begin{bmatrix} \cos\theta_r & -\sin\theta_r \\ \sin\theta_r & \cos\theta_r \end{bmatrix} \quad (10)$$

$$L_{ms} = \frac{N_s^{\,2}}{R_m} \quad (11)$$

$$L_{sr} = \frac{N_s N_r}{R_m} \quad (12)$$

In the equation, the inductance L_{ls} is the leakage inductance, the mutual inductance between the stator winding and the stator winding is L_{ms}, and the mutual inductance between the rotor winding and the stator windings is L_{sr}. Then, the electrical torque :

$$T_e = \frac{N_p}{2}(i_{abr})^T \frac{\partial}{\partial \theta_r}\left[(L_{sr})^T\right] i_{abr} \qquad (11)$$

we obtain :

$$T_e = \frac{N_p}{2}[L_{sr} i_{m}(-i_{ar}\sin\theta_r - i_{br}\cos\theta_r) + L_{sr} i_{aux}(i_{ar}\cos\theta_r - i_{br}\sin\theta_r)] \qquad (12)$$

And the dynamic equation of the load on ceiling fan is:

$$T_e = J\frac{d}{dt}\omega_m + B\omega_m + T_L \qquad (13)$$

3. Experimental Results

3.1 Conventional Ceiling Fan

Fig. 7 shows the measurement power on the power consumption. The conventional fan based on split-phase induction motor is listed under the single-phase power supply 110V. The consumption of the electric power on the motor corresponding to 3 steps speed control is listed in the Table I. Those test results are measured by using the power analyzer PM3000. The conventional fan has very poor power factor because of the power for the control reason has the larger harmonics. The power consumption are 12W, 8W, and 6W during the speed control.

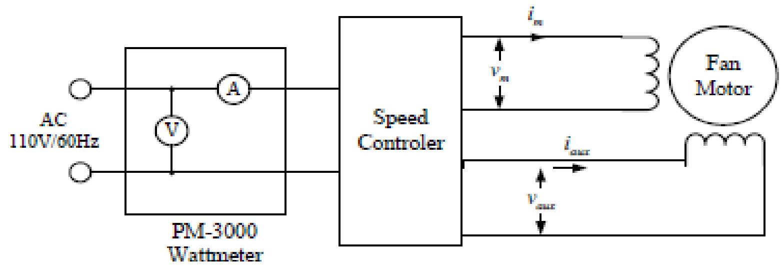

Fig.7. power consumption on the conventional fan motor

Table I

Measurement results on the conventional fan

IM	Rotation (rpm)	P(W)	PF	Noise (dB)	I_{THD} (%)	*S* (VA)
Fast	87.7	11.71	0.6	45.76	126.20	19.5
Mid	69	8.09	0.35	36.07	169.50	23.6
Slow	59.3	6.02	0.33	35.09	144.80	18.72

3.2 PWM Control of 110V Motor

The traditional fan motor (110V) is control under unipolar PWM methods. The consumption of the electric power on the motor corresponding to 3 steps speed control is listed in the Table II. The conventional fan has good power factor near 0.8. The power consumption is 7.6W, 7.6W, and 5.4W during the speed control. The efficiency of the PWM is good during the load. Specially, the noise is reduced 10dB on any speed.

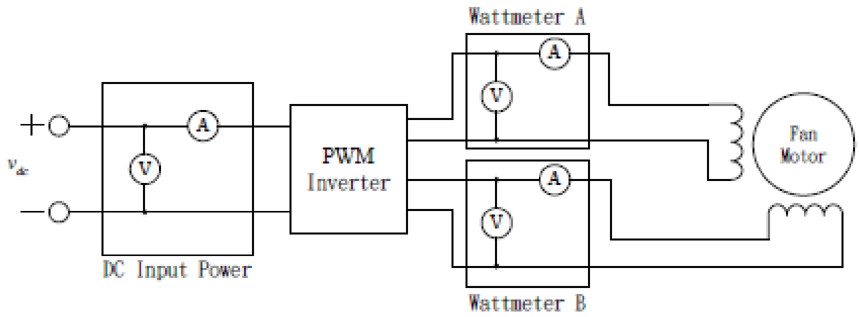

Fig.8. power consumption with PWM inverter on 110V motor

Table II

Measurement results on bipolar pwm control

110V 2ϕ	Rotation (rpm)	P(W)	PF	Noise (dB)	I_{THD} (%)	*S* (VA)	V_{DC} (V)
Fast	86.6	7.53	0.61	37.35	1.70	12.89	110
Mid	70	7.63	0.766	32.18	1.60	10.63	110
Slow	59.6	5.424	0.792	23.41	3.00	7.05	90

3.3 PWM Control of 24V Motor

In order to improve the efficiency, the new 24V motor is designed. The consumption of the electric power on the motor(24V) corresponding to unipolar control is listed in the Table III. The fan has good power factor near 0.7. The power consumption is 7W, 7W, and 5W during the speed control. The efficiency of the unipolar PWM is very good during the test loads. Specially, the noise is also reduced about 20dB.

Table III

Measurement results on bipolar pwm control

24V IM	Rotation (rpm)	P(W)	PF	Noise (dB)	I_{THD} (%)	*S* (VA)	V_{DC} (V)
Fast	85.7	7.226	0.649	27	3.00	10.53	17
Mid	71.4	7.009	0.743	23	3.70	10.03	17
Slow	59.4	5.396	0.778	15	4.80	7.78	17

3.4 Efficiency and Noise Analysis

In the two-phase control, both voltages, v_a and v_b, apply to the main and the aux winding directly. The consumption of the electric power on the motor corresponding to two phase voltage and current is shown in Fig. 9. The conventional fan has poor power factor 0.6 and 0.3. The power consumption is 12W, 8W, and 6W during the speed control. The efficiency of the two-phase control is very good during the heavy load. During the light load, the efficiency is good. Specially, the noise is also reduced 20dB on any speed.

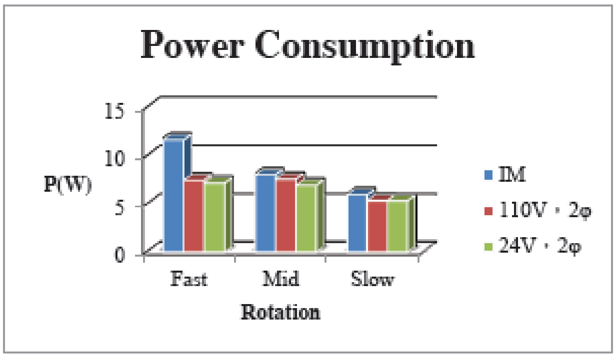

Fig.9. Power consumption on the fan motor

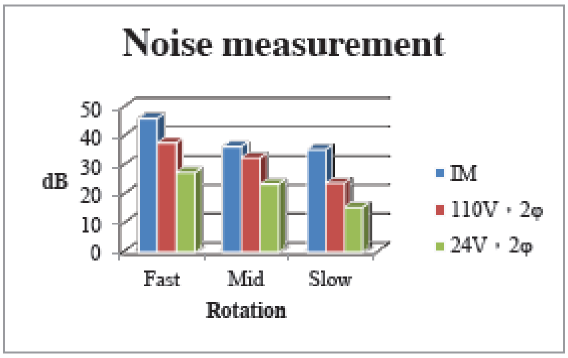

Fig.10. Noise reduction of the fan motor

4. Conclusion

The electrical fan, based on the induction motor, operate with very low efficiency on the high slip, when the speed control is used by the series inductors or resistors. In order to improve the efficiency, inverter benefit with unipolar Pulse Width Modulation (PWM) methods is used. The new type two-phase speed control is first designed and compared with the conventional methods by using the two-phase theory. The voltage source inverter with three legs provides two-phase voltages, v_a and v_b, to the main and the aux winding in the single-phase induction motor.

The experimental test shows that the efficiency of the vary frequency inverter on the fan is improved. The unipolar PWM and the two-phase control is much better for that of the traditional control. This means that the consumption of the fan based on the induction motor is improved for any of V/F control. It also has the benefit of noise reduction about 20dB.

5. Acknowledgment

The author's thanks for the support of the National Science Council, Taiwan, R.O.C.. Project number 102-2622-E-150-004-CC3.

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