A

Seminar report

On

Induction Motor

Submitted in partial fulfillment of the requirement for the award of degree
Of Mechanical

SUBMITTED TO: **SUBMITTED BY:**

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Preface

I have made this report file on the topic **Induction Motor**; I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to ………….who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

Acknowledgement

I would like to thank respected Mr…….. and Mr. ……..for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present a seminar report. It helped me a lot to realize of what we study for.

Secondly, I would like to thank my parents who patiently helped me as i went through my work and helped to modify and eliminate some of the irrelevant or un-necessary stuffs.

Thirdly, I would like to thank my friends who helped me to make my work more organized and well-stacked till the end.

Next, I would thank Microsoft for developing such a wonderful tool like MS Word. It helped my work a lot to remain error-free.

Last but clearly not the least, I would thank The Almighty for giving me strength to complete my report on time.

CONTENTS

A Simple Speed Control Method for Small Induction Motors Base on Phase Difference

Abstract - Some form of simple control is needed for small induction motors. This paper proposes a simple speed control method for small induction motors using a simple calculation without the need for a speed sensor. In this method, the load torque is estimated from the detected power factor of the induction motor and the speed of the induction motor is compensated for by a frequency-boost technique. The boost frequency is selected from a data table measured before hand. Satisfactory experimental results are obtained with 9OW induction motors**.**

I .INTRODUCTION

The induction motor is one of the most widely used actuators for industrial applications today mostly because of its low cost, ruggedness and reliability. The important parameters of an induction motor that are susceptible to uncertainties on operating conditions are the load torque and rotor resistance. Induction motor is basically a simple, cheap, and reliable machine which can provide excellent characteristics. In recent years, with the development of the technology for the adjustable speed drive of induction motors, the research in field-oriented control has been advanced on the control of induction motors. Especially, the speed sensor less control is greatly developed. When a rapid response is not required, and in order to lower the cost of controllers for small induction motors, some form of simple speed control is needed that does not require an expensive pulse-encoder and DSP. Because the stator current of small induction motors is small and the variations of current are very small when the load fluctuates, and since the noise of inverter current is large, the detecting of the variations of current is quite difficult. Although detecting the stator currents is difficult, the variation of the phase difference can be easily detected when the load is fluctuating. This paper presents a new speed sensor less control method based on the phase difference of the stator current for small induction motors. In this system, the speed fluctuations are estimated by the phase difference of the stator currents. The inverter frequency is calculated using a data table that has been measured previously, and adjusted to compensate for the fluctuation of rotational speed. The steady-state and the transient torque-speed characteristics are measured to confirm that this method can be easily applied to 9OW induction motors. Single phase induction motors are widely used, due to their simplicity, strength and high performance. They are used in household appliances, such as refrigerators, freezers, air conditioners, hermetic compressors, washing machines, pumps, fans, as well as in some industrial applications.

PRINCIPELE

A. Calculating the Phase Difference Using an Equivalent Circuit

In order to control the speed of the induction motor without a speed sensor, it is necessary to estimate the torque. For estimating rotor speed, the power factor is an important parameter. The relationship between torque and phase difference can be easily understood from the measured values shown in Fig.1. Here, the phase difference is converted to a time difference. If the load torque changes, the phase difference must also changes under the condition that the motor rotates at the preset speed. The fluctuation of the torque is presumed by detecting the phase difference between the stator voltage and the stator current of the motor. Motor slip can then be estimated.

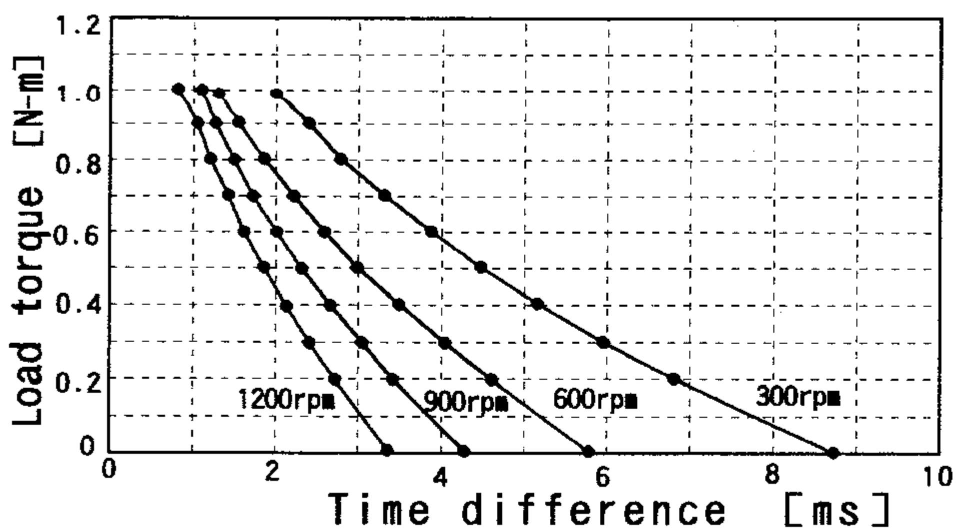


Fig.1 Characteristics of the torque versus the time difference

Figure 2 shows an L-type equivalent circuit, where V1 is the stator voltage, I1 is the stator current, r1 is the stator resistance, f is the operating frequency, x (=2*3.142*FL) is the leakage reactance of both the stator and rotor, r2 is the rotor resistance referred to on the primary side of the motor and *s* is the slip. The power factor of the induction motor can be obtained as follows using the parameters shown in Fig.2:

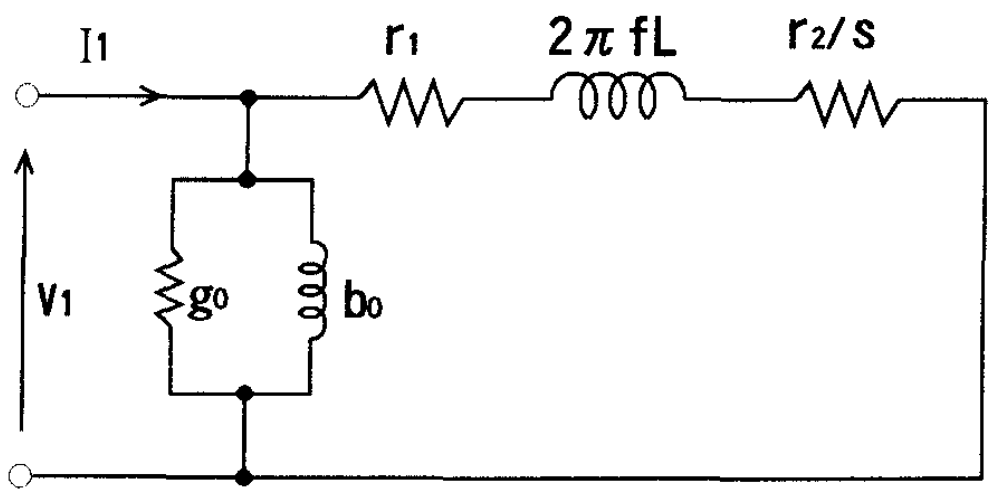


Fig2 L-type equivalent circuit

$$\cos\theta = \frac{g_0 + \dfrac{r_1 + r_2/s}{Z^2}}{Z_1} \qquad (1)$$

Where,

$$z_1 = \sqrt{\left(g_0 + \frac{r_1 + r_2/s}{z^2}\right)^2 + \left(b_0 + \frac{2\pi fL}{z^2}\right)^2} \qquad (2)$$

In the above equation, θ is defined only in terms of the operating frequency f and slip s.

B Relations Between Operating Frequency and Phase Difference θ

In this control system, the relations between operating frequency and phase difference θ of the primary circuit are measured previously under the condition that the rotational speed of the induction motor is held constant, even if the load torque varies. Figure 3 shows the characteristics of operating frequency versus the phase difference θ when the rotational speed of the motor is 300rpm, 600rpm, 900 and 1200rpm respectively. The solid line shows the measured value and the dotted line shows the calculated value. Furthermore, the phase difference is converted to a time difference in order to measure the phase difference more easily using a digital counter. Next, the results of these characteristics are stored in a microprocessor as a data table. When the load torque changes, the rotational speed of the motor also changes. For the motor to maintain a constant speed, the operating frequencies are calculated by the microprocessor using the characteristics in Fig.3 to increase or reduce the frequency. Although only four kinds rotational speed are shown in Fig.3, linear interpolation can be used to calculate the values at another speed.

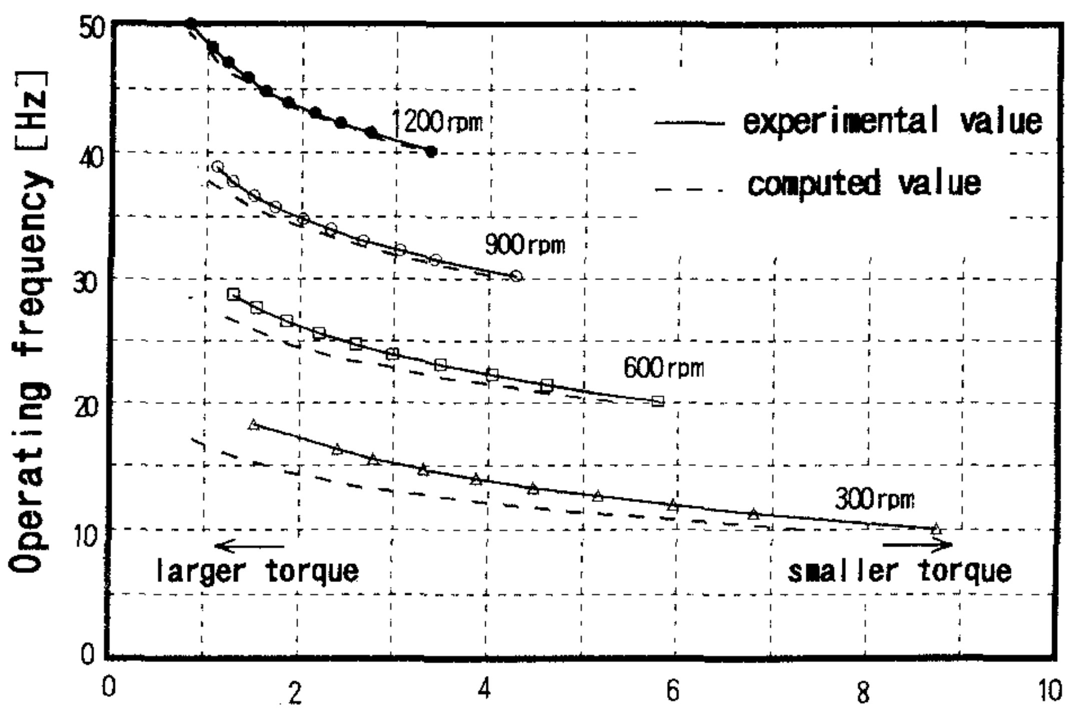
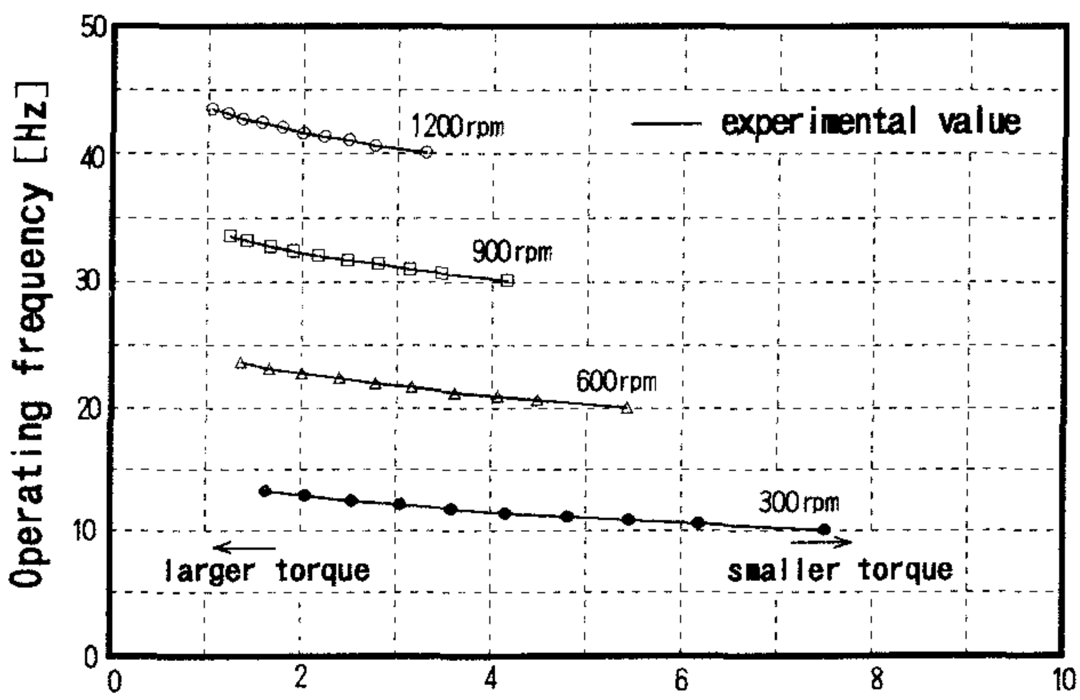


Fig.3 Relation between operating frequency and time difference (Type A motor)

C. Characteristics Caused by Varying Rotor Resistance

understood by varying the parameters in an In the same way the behavior of the induction motor and its control system can be more easily equivalent circuit, an induction motor with a smaller rotor resistance is examined. Figure 4 shows the relations between the phase difference and the operating frequency using a motor with a smaller rotor resistance. Compared with Fig.2 and Fig.3, it is clear that the amount of frequency increase or decrease needed to maintain constant speed is lower in the small rotor-resistance motor under the same load torque and phase difference conditions. This result is easily understandable given the proportional shifting characteristics of the torque that is used in the rotor resistance control of the wound-rotor induction machine.



Time difference [ms]

Fig.4 Relation between operating frequency and time difference

(Type B motor)

I11 . CONFIGURATION OF CONTROL SYSTEM

Fig5 shows the configuration of the control system. The PWM inverter controls the voltage/frequency ratio to maintain a constant value. The filters reduce the noise from the stator voltage signal and the current signal of the induction motor. The detection circuit of the phase difference detects the phase difference between the stator current and stator voltage and converts it to a pulse duration that is equivalent to the time difference. The counter circuit converts the time difference to a digital value. The microprocessor stores the data table containing the relation between the operating frequency and the phase difference, and calculates the instructional value needed for the inverter frequency. The D/A converter circuit converts the instructions of the frequency analog value because a commercially available PWM inverter is used. As shown in Fig.5,

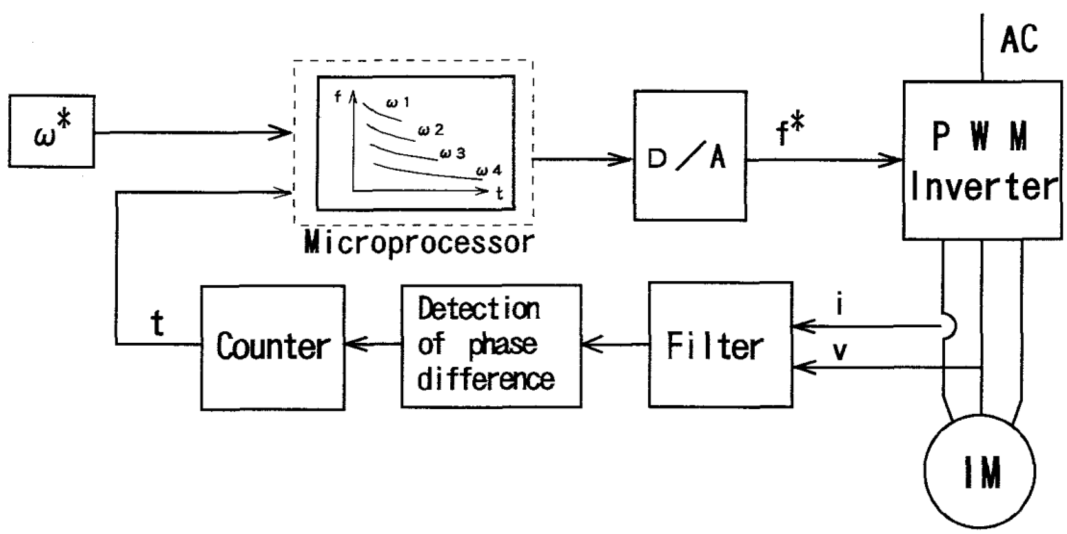


Fig5 Block diagram of the Control System

The preset rotational speed signal w * is sent to the microprocessor and the calculated frequency instructions f* is sent to the PWM inverter through the D/A converter. The PWM inverter receives this signal and drives the induction motor. In the adjustable speed controller, when the load varies, the phase difference θ of the stator current is detected. The microprocessor responds to the detected time difference and calculates the instructional value of frequency f* needed to adjust the motor rotational speed to the preset speed w *. The frequency f* will becomes higher when θ is smaller because the load increases, and becomes lower when θ is larger because the load decreases. The operating frequency is adjusted to compensate for changes in the rotational speed, thus maintaining constant the motor speed. In this control system, the detection of the phase difference is performed twice within one cycle of the operating frequency as follow: detection is performed once per 10ms at 50Hz operation and per 25ms at 20Hz operation. Therefore, sudden variations can not be detected. Consequently, this method can not be responded quickly within 10ms. A single-board computer (MCS BASIC 52) is used, with a built-in 8-bit BASIC interpreter. Since the program is described by the BASIC language, the development is easy, but the operating speed is slower. The total calculation time is on the order of several tens of milliseconds, so the control system is well-suited to the motor control.

EXPERIMENTAL RESULTS OF STEADY-STATE TORQUE CHARACTERISTICS

The rated values of the small induction motor used in this experiment are shown in Table1.

number of poles	4
rated voltage	200[V]
rated current	0.75[A]
rated output	90[W]
frequency	10～60[Hz]

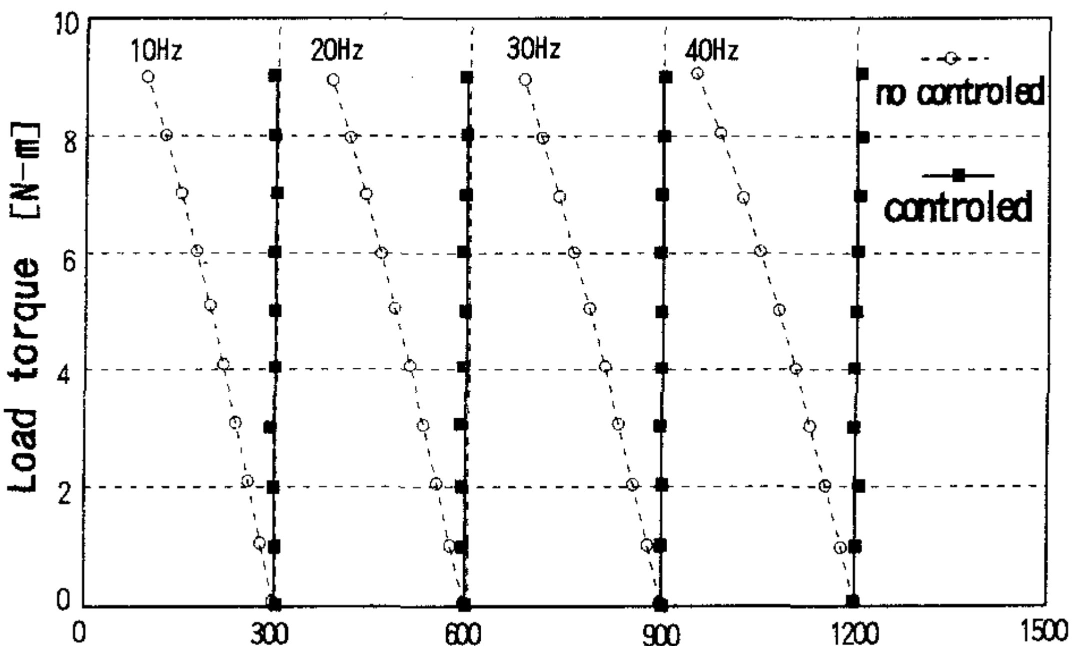
Table 1 Rated values of tested machine

And the parameters of the L-type equivalent circuit are shown in Table 2. For the two types of motors (type A has a larger rotor resistance; type B has a smaller resistance),

	Type A motor	Type B motor
g0[mS]	0.824	1.03
b0[mS]	4.86	5.62
r1[Ω]	22.9	23.0
r2[Ω]	29.0	11.4
x[Ω]	39.1	27.4

Table 2 Parameters of L-type equivalent circuit

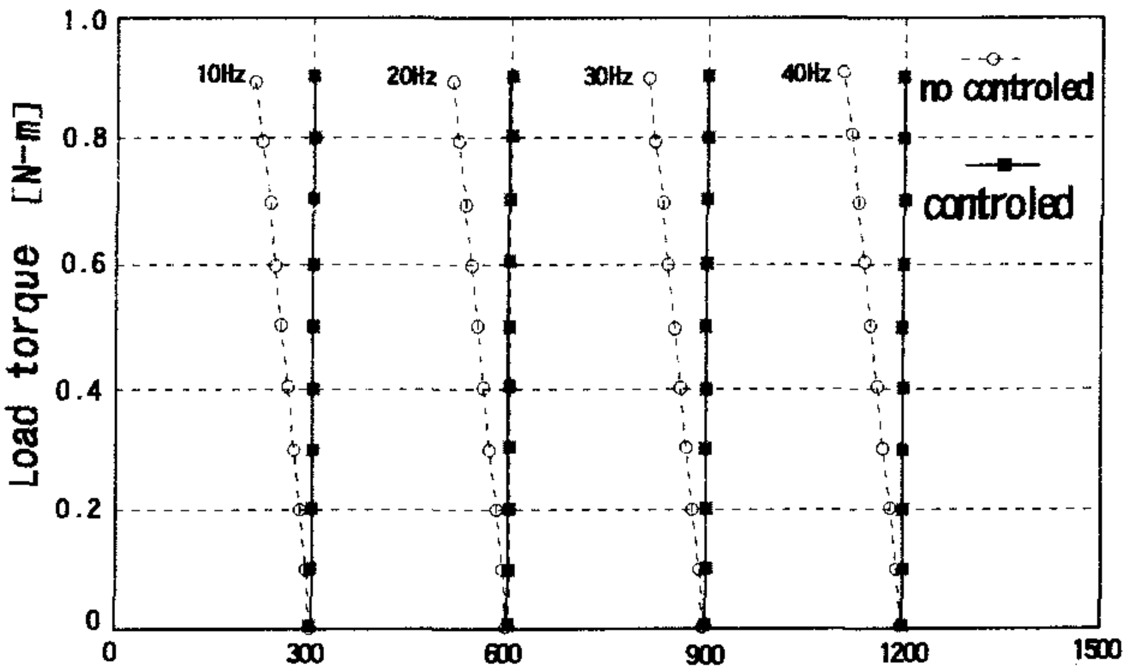
The measured characteristics of steady state torque versus the rotational speed are shown in Fig.6 and Fig.7. The dotted lines show the performance characteristics without control, and the solid lines show the performance characteristics with the proposed control. The rotational speed is measured as the load change from 0 to 0.9[N-m]



Rotational speed in [RPM]

Fig 6 Torque-speed characteristic (Type A motor)

Fig.6 shows the steady-state toque characteristics of the type A motor. As shown in Fig.6, the type A motor is driven at 40Hz and rotates at about 1200rpm" under no-load conditions, and rotates at 972rpm (decrease of about 20%) when the load torque increases to (1.9N-mJ without the control. The motor is driven at l O H z and rotates at 300rpm under no-load conditions, and rotates at 97rpm (decrease of about 67%) when the load torque increases to 0.9 [N-m] without the control. When the load increases, slip also increases and the speed slows down. When the proposed control system is applied, the rotational speed remain almost constant, even when the load increases to 0.9 [N-m]



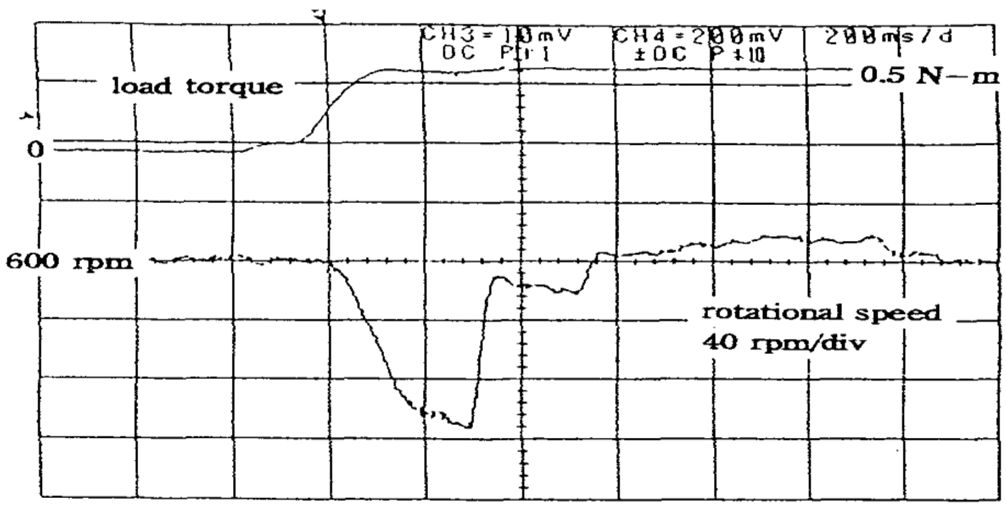
Rotational speed [rpm]

Fig 7 Torque-speed characteristic (Type B motor)

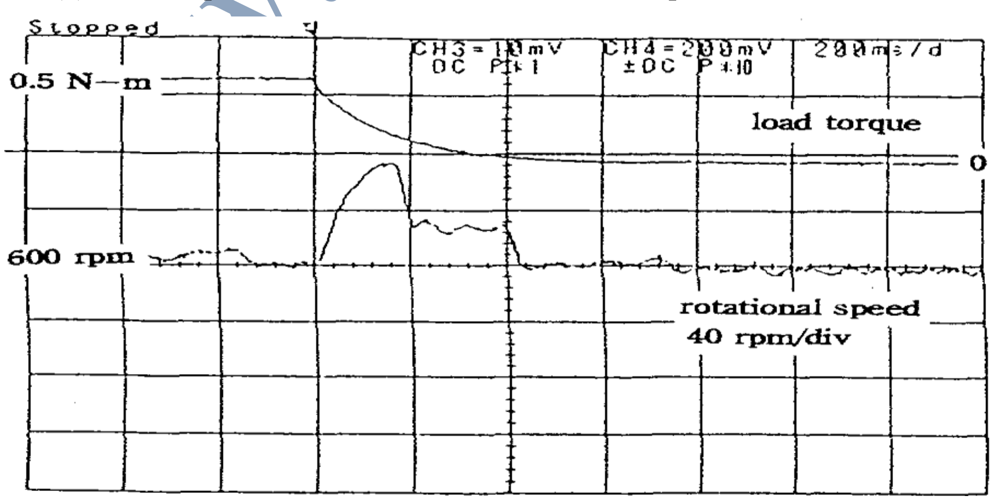
Fig.7 shows the experimental results of the steady state torque characteristics of the type B motor. When the speed control is not applied, the rotational speed drop is smaller compared with the type A motor as shown in Fig.6. However, the rotational speed characteristics *are* the same as in Fig.6 where the proposed control system is used. In the experiment, there is a speed error of about +_ 5 - lOrpm due to the negative influence of noise under actual speed control conditions.

V .TRANSIENT RESPONSE CHARACTERISTICS

Steady state torque characteristics were obtained. However, the motors were to suffer a sudden change in load torque, the rotational speed would vary for a moment. Figs.8 and 9 show the experimental results of rotational speed variation when load torque is varied in a step change. Figure **8** shows the characteristics of the transient response for the type A motor. The situation in which load torque is varied from zero to the rated torque is shown in Fig8(a), and the response time takes about 0.56 second. The situation in which the load torque is varied from the rated torque to zero is shown in Fig8(b), and the response time is about **0.44** second.



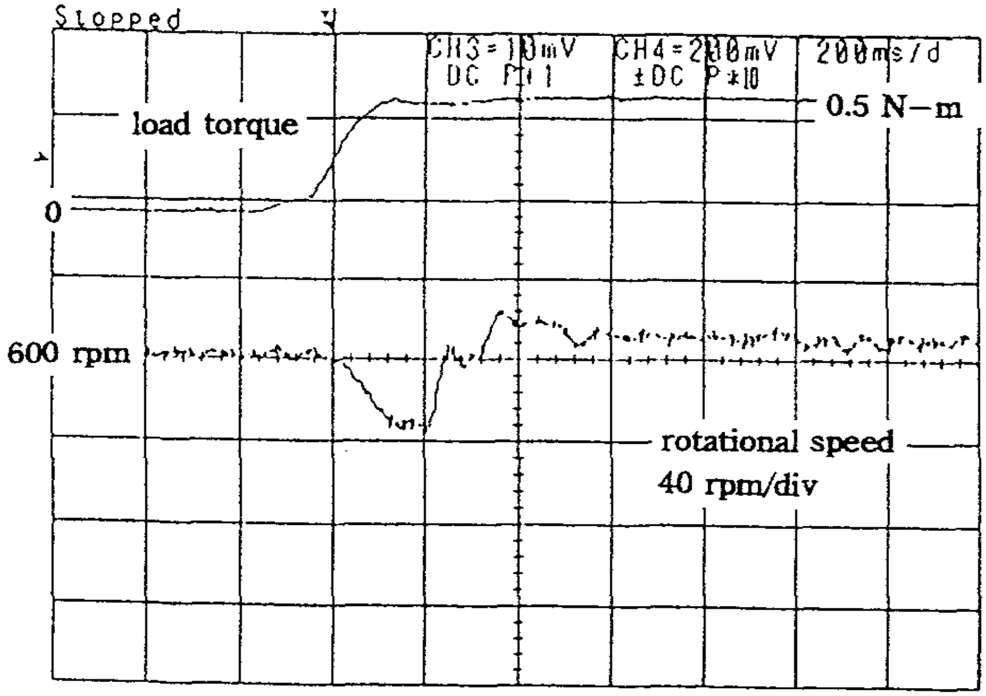
(a) load torque is varied from zero to the rated torque



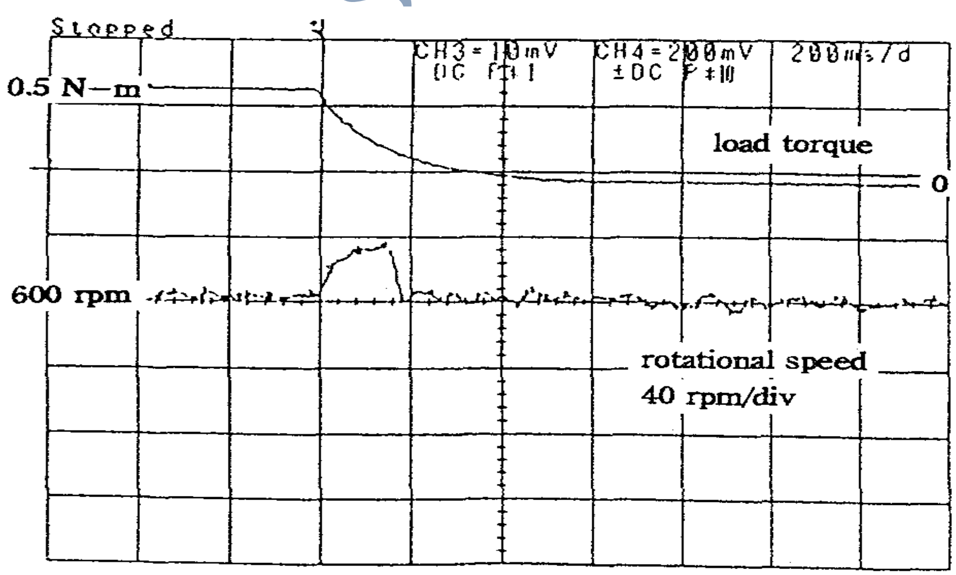
(b) load torque is varied from the rated torque to zero

Fig.8 Transient response characteristics (Type A motor)

Fig.9 shows the transient response characteristics in the same way as in Fig.8 for the type B motor. Compared with the Type A motor, the maximum value of the speed change Is smaller by about 50% and the response time is quicker by about half, as shown in Fig.9.



(a) load toque is varied from zero to the rated torque



(b) load torque is varied from the rated torque to zero

Fig.9 Transient response characteristics (Type B motor)

VI . CONCLUSIONS

In this paper, a new method is proposed for maintaining an average speed constant using a simple control system. The features of the method are that a speed-sensor is not used, and only the phase difference between the voltage and current is detected. Moreover, the inverter frequency is determined by the data table measured previously by means of a simple calculation. Using this method, the torque-speed characteristics are improved greatly, and system performance is confirmed. The satisfied results for constant speed control are obtained by the experiments. This control system is simple and is easily applied. This method is useful for controlling small induction motors.

REFERENCES

- www.google.com
- www.wikipedia.com
- www.studymafia.org
- www.pptplanet.com