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400Hz 恒压恒频逆变器的一种模糊-重复混合控制方案

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A HYBRID FUZZY-REPETITIVE CONTROL SCHEME FOR 400HZ CVCF INVERTERS

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ABSTRACT: In this paper a hybrid fuzzy-repetitive control scheme for 400Hz constant-voltage constant-frequency (CVCF) inverters is presented. The fuzzy PD controller is used to improve transient performance whenever the system exhibits an oscillatory or overshoot behavior. Repetitive controller is applied to generate high-quality sinusoidal output voltage in steady state. Thus, the fuzzy PD controller and repetitive controller can be combined to take advantage of their positive attributes. The control scheme is implemented using a TI TMS320F240 DSP in a 400Hz 5.5kW prototype. Experimental results prove that the proposed control scheme can achieve not only low THD during steady-state operation but also fast transient response subject to load step change.

KEY WORDS: Electric machinery electrotechnology; Digital Signal Processors; 400Hz CVCF inverters; Fuzzy control; Repetitive control

摘要：针对 400Hz 恒压恒频（CVCF）逆变器，提出了一种模糊-重复混合控制方案。模糊 PD 控制器用于改善系统处于振荡或过冲时的动态性能，重复控制器用于稳态时输出高质量的正弦电压。因此模糊 PD 控制器和重复控制器的混合可以利用它们各自的优点，该控制方案采用 TI 的 DSP 芯片 TMS320F240 在一台 400Hz、5.5kW 样机上得以实现。实验结果验证了所提出的控制方案不仅能在稳态时获得低 THD 的输出电压，而且在负载突变时获得了较好的动态性能。

关键词：电机电工；数字信号处理器；400Hz 恒压恒频逆变器；模糊控制；重复控制

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1 INTRODUCTION

In recent years, single-phase constant-voltage constant-frequency (CVCF) inverters have been widely employed in UPS. The output voltage of CVCF inverter is required to follow a sinusoidal command. Its performance is evaluated in terms of output voltage waveform distortion with linear or nonlinear loads and transient response due to sudden changes in the load.

With the availability of high-frequency switching devices and high-performance microprocessors, many digital control schemes with output voltage feedback have been applied to the closed-loop regulation of the CVCF inverters. Deadbeat-controlled PWM inverter has very fast response for load disturbances and nonlinear loads. But in the deadbeat control approach, the control signal depends on a precise PWM inverter load model and the performance of the system is sensitive to parameter and load variations. Sliding mode control of inverter has proved quite useful against parameter variations and external disturbances. However, the well-known chattering problem must be especially taken care in digital realization of the control algorithm. Repetitive control, which modifies the reference command by adding a periodic compensation signal, is applied to generate high-quality sinusoidal output voltage in the inverter whereas its dynamic response is poor [1-2].

In this paper, a hybrid fuzzy-repetitive control scheme for single-phase CVCF inverters is presented. The principle of the proposed control scheme is to use a repetitive controller, which performs satisfactorily in steady state, while a fuzzy PD controller improves transient performance whenever the system exhibits an oscillatory or overshoot behavior. The main improvement of fuzzy PD controller is in endowing the classical PD controller with a certain adaptive control capability. Fuzzy logical controller (FLC) can handle nonlinearity and does not need accurate mathematical model. It is represented by if-then rules and thus can provide an understandable knowledge representation.

The control scheme is implemented using a TI TMS320F240 digital signal processor (DSP). Experimental results prove that the proposed control scheme can achieve not only low THD during steady-state operation but also fast transient response subject to load step change.

2　INVERTER SYSTEM MODEL

400Hz inverters have been widely used in applications where space and weight are at a premium. Because of a higher fundamental frequency than 50Hz system, passive components in a 400Hz system can be much smaller. But in a 400Hz inverter, the ratio between the switching frequency and the fundamental output frequency is significantly decreased. This makes the goal of achieving high power quality a more difficult task.

Fig. 1 shows the equivalent circuit and block diagram representation of a single-phase 400Hz CVCF inverter. In the output filter of the inverter, L and C_1 forms a series resonant circuit for 400Hz. Dead-time effect and inevitable loss in every part of the inverter offered a little damping. The damping effect can be summarized as a small resistor connected in series with the filter inductor. Since the switching frequency is much higher than the natural frequency and modulation frequency, the dynamics of inverter are mainly determined by the output filter and connected load.

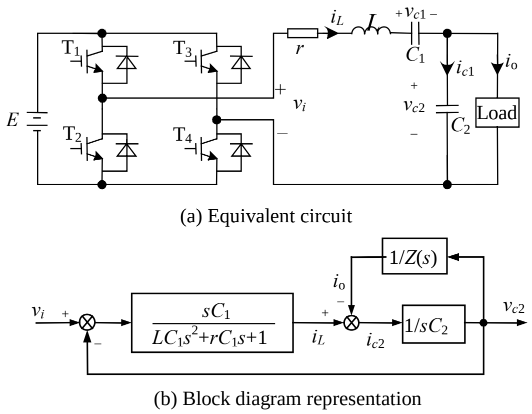


图 1　单相 400Hz CVCF 逆变器

Fig. 1　Single-phase 400Hz CVCF inverter

Based on the state-space averaging and linearization technique, the state equations of the inverter can be obtained as

$$\frac{\mathrm{d}}{\mathrm{d}t}\begin{bmatrix} v_{c1} \\ v_{c2} \\ i_L \end{bmatrix} = \begin{bmatrix} 0 & 0 & \frac{1}{C_1} \\ 0 & 0 & \frac{1}{C_2} \\ -\frac{1}{L} & -\frac{1}{L} & -\frac{r}{L} \end{bmatrix} \begin{bmatrix} v_{c1} \\ v_{c2} \\ i_L \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ 0 & -\frac{1}{C_2} \\ \frac{1}{L} & 0 \end{bmatrix} \begin{bmatrix} v_i \\ i_o \end{bmatrix} \tag{1}$$

Due to the diversity of the loads connected to an inverter, it is impossible to formulate a general model to cover every kind of load. The load current can be considered as an exogenous disturbance. Under unloaded conditions, the output filter is most lightly damped and will have significant peak (typically 20dB) at the resonant frequency. Because the peaking of the output filter can cause the inverter to become unstable, measures must be taken to ensure appropriate stability margins under unloaded conditions. The responding transfer function of the inverter under no load can be derived as

$$P(s) = \frac{v_{c2}(s)}{v_i(s)} = \frac{C_1}{LC_1C_2s^2 + rC_1C_2s + C_1 + C_2} \tag{2}$$

However, it is difficult to evaluate the damping resistor r through theoretical analysis. In this paper, an experiment is adopted to measure the frequency characteristics of the inverter under no load and determine the damping resistor.

From (2), a discrete transfer function can be obtained using a zero-order hold with an appropriate sampling period T,

$$P(z^{-1}) = Z[\frac{1-e^{-Ts}}{s}P(s)] = \frac{b_1 z^{-1} + b_2 z^{-2}}{1 + a_1 z^{-1} + a_2 z^{-2}} \quad (3)$$

Conventional control approaches require a good knowledge of the system and accurate tuning in order to obtain desired performances. The design of a conventional closed-loop controller becomes difficult because the load connected to the inverter is usually nonlinear and unpredictable. Therefore the FLC may be a good alternative to solve this problem.

3 HYBRID FUZZY-REPETITIVE CONTROL

3.1 General View

The regulation characteristic of a fuzzy controller is different to the linear controller because the FLC is mostly nonlinear and make a lot of adjustment possible [3-4]. The fuzzy controller is able to reduce both the overshoot and extent of oscillations. But it cannot provide better small-signal response. Thus, repetitive control is applied to generate high-quality sinusoidal output voltage in steady state. It may be possible to take advantage of both controllers to possibly produce a hybrid controller more effective than either one of the two separately.

Fig. 2 shows the proposed fuzzy-repetitive control scheme of an inverter. The fuzzy PD controller plays an important role in improving an overshoot and a rise time response during severe perturbations. The repetitive controller can minimize periodic distortions resulted from unknown periodic load disturbances so as to achieve low THD sinusoidal output in steady states. Both of them will be presented in the following subsections.

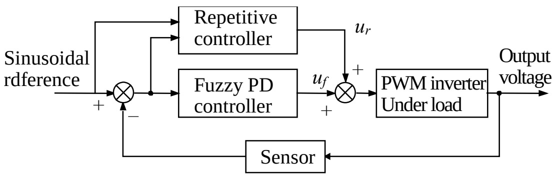


图 2 控制器方框图

Fig. 2 Block diagram of the proposed controller

3.2 Fuzzy PD controller

Among all of the digital control techniques, the digital PID controller has been used in many industrial control systems. The main reason is due to its simplicity of operation, ease of design, inexpensive maintenance, low cost and effectiveness for most linear systems. Due to inclusion the repetitive controller in the control law, it is possible to eliminate the integral action from the PID controller without degrade the performance of the system.

(1) Principle of PD control

It is well known that PD controller can reduce overshoot and permit the use of larger gain by adding damping to the system. The direct digital approach base on the frequency response method in the w-plane is used in design process. The transfer function of a PD controller in w-plane has the following form

$$G_{\mathrm{PD}}(w) = k_p + k_d w \quad (4)$$

or

$$G_{\mathrm{PD}}(w) = k_p(1 + \tau w) \qquad \tau = k_d / k_p \quad (5)$$

k_p and k_d are the proportional and derivative gains respectively. According to the classical control theory, the effects of individual P/D actions of a controller has been summarized as follows:

P: speed up response, decrease rise time, and increase overshoot.

D: increase the system damping, decrease settling time.

For physical realization of this controller, the transfer function of a PD controller can be modified as

$$G_{\mathrm{PD}}(w) = \frac{k_p(\tau w + 1)}{\alpha \tau w + 1} \quad \alpha \in [0.01, 0.1] \quad (6)$$

Based on $w = (2/T)[(z-1)/(z+1)]$, the z-plane expression of this controller is

$$G_{\mathrm{PD}}(z^{-1}) = k_p \frac{(T + 2\tau) + (T - 2\tau)z^{-1}}{(T + 2\alpha\tau) + (T - 2\alpha\tau)z^{-1}} \quad (7)$$

However, the PD-type controller cannot yield a good control performance if the controlled object is highly nonlinear and uncertain.

(2) Design of fuzzy PD controller

The main improvement of fuzzy PD controller is in endowing the classical PD controller with a certain adaptive control capability. The parameters of the PD controller k_p and k_d are determined based on the error $e(k)$ and the change of error $ce(k) = e(k) - e(k-N)$. The new fuzzy PD controller thus preserves the simple linear structure of the conventional PD controller yet enhances its self-tuning control capability. In this way system stability and a fast large-signal dynamic response with a small overshoot can be achieved with proper handling of the proportional and derivative part as described hereafter.

Fig. 3 shows a block diagram of fuzzy logical controller[5-6]. The fuzzy PD controller is used to compensate for the voltage oscillation of the inverter due to sudden load changes.

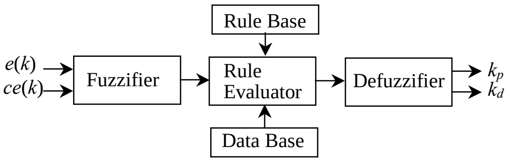


图 3 模糊逻辑控制器方框图

Fig. 3 Block diagram of the fuzzy logical controller

Fuzzification converts crisp data into fuzzy sets, making it comfortable with the fuzzy set representation of the state variable in the rule. In the fuzzification process, normalization by reforming a scale transformation is needed at first, which maps the physical values of the state variable into a normalized universe of discourse. The universe of discourse for error and change of error may be adjusted from open loop simulations. In the paper, the membership functions of these fuzzy sets for $e(k)$, $ce(k)$, k_p and k_d are shown in Fig. 4 respectively.

Fig. 5 shows a typical step response of a second order control system. In order to design the control-rule base for tuning k_p and k_d, the following important factors have been taken into account:

(a)Around point '*a*' in Fig. 5, a big control signal is needed so as to have the dynamic response as fast as possible. Therefore, a larger k_p and a smaller k_d are required.

(b)Around point '*b*' in Fig. 5, the system is converging toward the equilibrium point. Therefore, a smaller k_p and a larger k_d are required to prevent the system from oscillating further.

(c) Around point '*c*' in Fig. 5, the system is diverging away from the equilibrium point. Therefore, a larger k_p and a larger k_d are required.

(d) Around point '*d*' in Fig. 5, a larger k_p and a larger k_d are required to make the controller produce a lower overshoot and reduce the settling time.

(e) Around point '*e*' in Fig. 5, a larger k_p and a smaller k_d are required just like point '*a*'.

(f) Around point '*f*' in Fig. 5, a smaller k_p and a larger k_d are required just like point '*b*'.

(g) Around point '*g*' in Fig. 5, a larger k_p and a larger k_d are required just like point '*c*'.

(h) Around point '*h*' in Fig. 5, a larger k_p and a larger k_d are required just like point '*d*'.

(i) For small/zero values of $e(k)$ and large $ce(k)$, the system is near the equilibrium point. Therefore, the controller should operate with the nominal values of the gains.

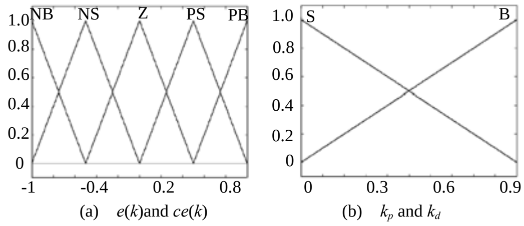


图 4 模糊变量的隶属度函数

Fig. 4. Membership functions of fuzzy variables

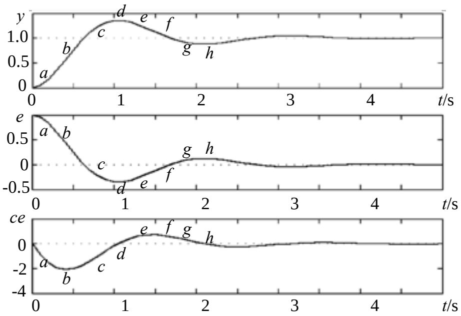


图 5 二阶控制系统的典型阶跃响应

Fig. 5 A typical step response of a second order control system

According to these criteria, a rule table is derived and shown in Tab.1. The inference method employs MAX-MIN method. The output membership function of each rule is given by minimum operator, whereas the combined fuzzy output is given by maximum operator. The imprecise fuzzy control action generated from the inference must be transformed to a precise control action in real application. The center of mass (COM) method is used to defuzzify the fuzzy variables in the paper. Output denormalization maps the normalized value of the control output variable into physical domain.

It is well known that fuzzy PD controller cannot provide better small-signal response. Thus, repetitive controller is used to get low THD in the steady state.

表 1 模糊调节规则

Tab. 1 Fuzzy Tuning Rules

(a) k_p

CE \ E	NB	NS	Z	PS	PB
NB	B	B	S	S	B
NS	B	B	S	S	B
Z	B	B	S	B	B
PS	B	S	S	B	B
PB	B	S	S	B	B

(b) k_d

CE \ E	NB	NS	Z	PS	PB
NB	B	B	B	B	S
NS	B	B	B	B	S
Z	S	S	B	S	S
PS	S	B	B	B	B
PB	S	B	B	B	B

3.3 Repetitive controller

The main drawback of SPWM inverter is large THD with nonlinear loads such as rectifier and triac loads. Besides, dead-time effect will result in large THD of the output voltage. The nonlinear load and dead-time effect can be regarded as a periodic disturbance. Repetitive control provides an alternative to minimize periodic error occurred in a dynamic system.

(1) Principle of repetitive control

Repetitive control is based on the internal model principle. The internal model principle means that the controlled output tracks a set of reference commands without a steady-state error if the generator for the references is included in the stable closed-loop system. Repetitive control can be regarded as a simple learning control because the control input is calculated using the information of the error signal in the preceding periods[7].

Fig. 6 shows a block diagram of a plug-in type repetitive control system. The repetitive controller calculates correction component from output voltage error. Then the correction component is added to the original sinusoidal reference to achieve waveform correction.

The transfer function from the disturbance input $d(k)$ to the tracking error $e(k)$ is

$$F(z^{-1})=\frac{E(z^{-1})}{D(z^{-1})}=\frac{1-Q(z^{-1})z^{-N}}{1-[Q(z^{-1})-S(z^{-1})P(z^{-1})]z^{-N}} \tag{8}$$

If $Q(z^{-1})$=1 and $P(z^{-1})$ is stable, the corresponding frequency function is

$$F(\mathrm{e}^{\mathrm{j}\omega T})=\frac{1-\mathrm{e}^{-\mathrm{j}\omega NT}}{1-[1-S(\mathrm{e}^{\mathrm{j}\omega T})P(\mathrm{e}^{\mathrm{j}\omega T})]\mathrm{e}^{-\mathrm{j}\omega NT}} \tag{9}$$

The reference command is a sinusoidal signal with period T_s=NT. If $d(k)$ is a periodic disturbance with the same period, it can be expressed as Fourier series whose angular frequency is $\omega=2\pi m/NT$ (m=0, 1, 2, …).

Thus, if $\omega=2\pi m/NT$ (m=0, 1, 2,…, $N/2$),

$$F(\mathrm{e}^{\mathrm{j}\omega T})=\frac{1-\mathrm{e}^{-\mathrm{j}2\pi m}}{1-[1-S(\mathrm{e}^{\mathrm{j}\omega T})P(\mathrm{e}^{\mathrm{j}\omega T})]\mathrm{e}^{-\mathrm{j}2\pi m}}=0 \tag{10}$$

It means that no steady-state error is obtained with the repetitive control for any periodic disturbance whose frequency is less than Nyquist frequency π/T.

The core of the repetitive controller is the modified internal model $1/(1-Q(z^{-1})z^{-N})$. Usually $Q(z^{-1})$ is a close-to-unit constant, typically 0.95. It relieves the stringent requirement of the repetitive controller to eliminate periodic error completely.

Applying the small gain theorem to the feedback loop of error system in Fig. 7, a sufficient condition for stability can be obtained,

$$|H(\mathrm{e}^{\mathrm{j}\omega T})|<1 \tag{11}$$

where $H(\mathrm{e}^{\mathrm{j}\omega T})=Q(\mathrm{e}^{\mathrm{j}\omega T})-S(\mathrm{e}^{\mathrm{j}\omega T})P(\mathrm{e}^{\mathrm{j}\omega T})$

$$\omega\in[0,\pi/T] \tag{12}$$

Inequation (11) indicates that the repetitive control system is sufficiently stable if the end of the vector $S(\mathrm{e}^{\mathrm{j}\omega T})P(\mathrm{e}^{\mathrm{j}\omega T})$ does not exceed the unity circle centered at the end of $Q(\mathrm{e}^{\mathrm{j}\omega T})$ while ω varies in $[0,\pi/T]$.

(2) Structure of compensator $S(z^{-1})$

In order to ensure stability and realize satisfactory harmonic rejection $|H(\mathrm{e}^{\mathrm{j}\omega T})|$ should be kept close to zero. With the limited system bandwidth, it is impossible to eliminate all harmonics completely. So the repetitive controller is synthesizing to minimize low-order harmonic distortion. To ensure stable operation at different load conditions, compensator design must be carried out under no load, when the resonant peak of the inverter is the highest.

Since the ratio between the switching frequency and the fundamental output frequency of 400Hz inverter is significantly decreased, the ratio between the resonant frequency and the fundamental output frequency is also small. In this paper, the ratio between the resonant frequency and the fundamental output frequency is about 3.4.

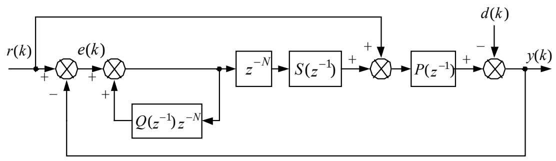


图 6 重复控制系统方框图

Fig. 6 Block diagram of repetitive control system

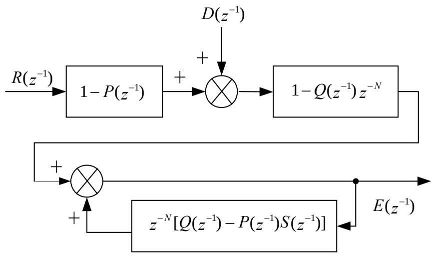


图 7 误差系统方框图

Fig. 7 Block diagram representation of the error

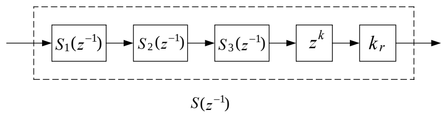


图 8 补偿器方框图

Fig. 8 Block diagram of the compensation

If a moving average filter [8] is chosen to cancel the resonant peak of 400Hz inverter under no load, harmonic rejection will be weakened. This is because the gain of moving average filter drops sharply in the neighborhood of resonant frequency. The low frequency gain of the plant is also significantly reduced. It renders the value of $|H(e^{j\omega T})|$ high in the low frequency region. As a result, satisfactory harmonic rejection cannot be obtained.

Fig. 8 shows a block diagram of the compensator $S(z^{-1})$. The inverse of inverter under no load $S_1(z^{-1})$ has stable poles because the inverter is a minimum-phase system[9]. The period delay unit z^{-N} as shown in Fig. 6 postpones the error correction by one fundamental cycle. So the inverse of inverter $S_1(z^{-1})$ is realizable. $S_1(z^{-1})$ is used to attenuate the resonant peak resulting from the inverter for the sake of stability. A moving average filter $S_2(z^{-1})$ and a second order filter $S_3(z^{-1})$ are used to make the system robust against parameter variations as well as unmodeled high frequency modes.

$$S_1(z^{-1}) = \frac{1}{P(z^{-1})} \tag{13}$$

$$S_2(z^{-1}) = \frac{\gamma_p(z^{-p}+z^p)+\gamma_{p-1}(z^{-(p-1)}+z^{p-1})+\cdots+\gamma_0}{2\gamma_p+2\gamma_{p-1}+\cdots+\gamma_0}$$

$$(\gamma_0 > \cdots > \gamma_{p-1} > \gamma_p) \tag{14}$$

$$S_3(z^{-1}) = \frac{az^{-1}+bz^{-2}}{1+cz^{-1}+dz^{-2}} \tag{15}$$

The magnitude of $P(z^{-1})S(z^{-1})$ should be equal to unit at lower frequency and be decreased significantly at higher frequency theoretically. Because the phase delay of $S_2(z^{-1})$ is equal to zero, the time advance unit z_k compensates for the corresponding phase delay resulting from $P(z^{-1})$ and $S_1(z^{-1})$ $S_3(z^{-1})$. The period delay unit z^{-N} postpones the error correction by one period so that it is possible to realize the time advance phase cancellation. So the system possesses a nearly zero-phase-shift characteristic in the low frequency range. The gain k_r is kept below one for stability. A smaller k_r means enlarged stability margin, but a higher k_r brings faster error convergence and smaller steady-state error.

Carefully selecting the controller parameters is a compromise between the convergent rate and relative stability of the repetitive control system [10].

(3) Design of compensator $S(z^{-1})$

The main parameters of the 400Hz inverter are listed in Tab.2.

表 2 逆变器元件参数

Tab. 2 Parameters of the inverter

Item	Nominal Value
DC link voltage E/V	400
Output voltage (RMS) v_o/V	230
Output frequency f_o/Hz	400
Rated output power P_o/kW	5.5
Filter inductor L/mH	0.73
Resonant capacitor C_1/μF	215
Filter capacitor C_2/μF	20
Filter resonant frequency f_r/kHz	1.37
Switching frequency f_{sw}/kHz	10
Sampling period T/μs	100
Dead-time t_D/μs	3.6

The model for the inverter with no load can be obtained as

$$P(z^{-1}) = \frac{0.3149z^{-1}+0.3076z^{-2}}{1-1.2533z^{-1}+0.9337z^{-2}} \tag{16}$$

Since the moving average filter $S_2(z^{-1})$ and the second order filter $S_3(z^{-1})$ have attenuated the resonant peak resulting from the inverter under no load. The inverse of inverter $S_1(z^{-1})$ need not cancel out the resonant peak completely. It can be modified for better harmonic rejection. Suppose Q=0.95, N=25, every part of the compensator can be designed as

$$S_1(z^{-1}) = \frac{3.2469 - 3.9416z^{-1} + 2.8307z^{-2}}{z^{-1} + 0.9542z^{-2}} \tag{17}$$

$$S_2(z^{-1}) = \frac{0.5940z^{-1} + 0.1537z^{-2}}{1 - 0.2707z^{-1} + 0.0183z^{-2}} \tag{18}$$

$$S_3(z^{-1}) = \frac{z^3 + 2z^2 + 3z + 4 + 3z^{-1} + 2z^{-2} + z^{-3}}{16} \tag{19}$$

$$z^k = z \tag{20}$$

$$K_r = 1 \tag{21}$$

The frequency response used in design process is shown in Fig. 9. In order to verify the stability of the repetitive controller, Fig. 10 shows the locus of the vector $S(e^{j\omega T})\ P(e^{j\omega T})$ while ω varies in $[0,\pi/T]$ under three kinds of loads. It is obvious that the repetitive control system is sufficiently stable.

The repetitive control improves the accuracy of the steady state response due to its property of removing periodic disturbances. Unfortunately, the repetitive control is known to be slow speed of response to dynamic variations of the operating conditions such as sudden changes in the load due to its open-loop manner in the first cycle of load change. So an instantaneous feedback control method needs to be included.

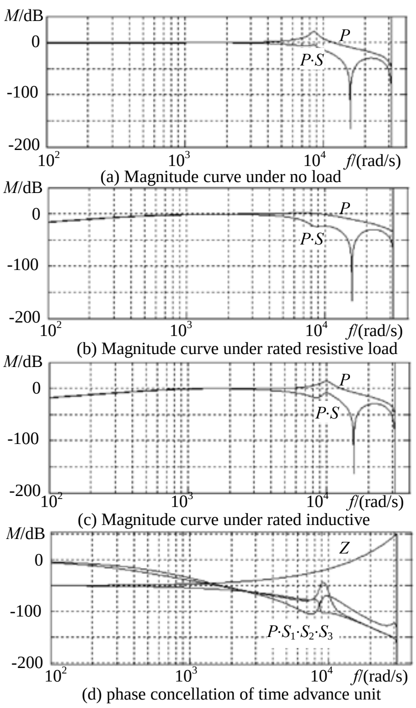


图 9 设计过程中的频率响应图

Fig. 9 Frequency response used in design process

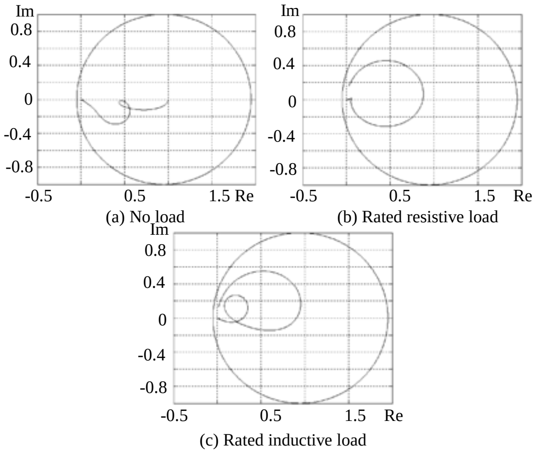


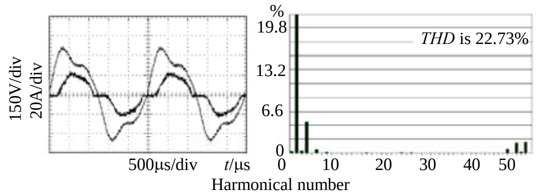
图 10 重复控制器的稳定性分析

Fig. 10 Stability analysis of the repetitive controller

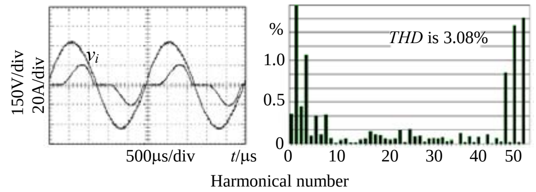
4 EXPERIMENTAL RESULTS

To verify the effectiveness of the proposed controller, a 400Hz 5.5kW inverter is constructed and the proposed algorithm is tested. Gating signals for the inverter are obtained using the unipolar PWM method, which is the comparison-based method between a single triangular carrier wave and two modulation voltage signals with an opposite phase each other. This method offers the advantage of effectively doubling the switching frequency of the inverter voltage, thus making the output filter smaller, cheaper and easier to implement. A single-chip DSP TMS320F240 provided by Texas Instruments is used to implement the proposed control scheme. The software approach is adopted to realize fuzzy-repetitive control algorithm. The fuzzy decision table is computed off-line using MATLAB. Then it is stored in the Flash EEPROM of DSP. The fuzzy tuning process is performed on a lookup table. So it can be executed very quickly.

Fig. 11 shows the experimental results for nonlinear load condition with SPWM and repetitive PD control. The nonlinear load was chosen as a bridge rectifier with an output LC filter (L=1mH, C=2200μF) and a resistive load (R=20 Ω). As in Fig. 11 the distortion of the output voltage of the proposed control system is decreased. It is obviously that the repetitive controller has good steady-state characteristics. However, it is not suitable for the applications with sudden load change due to their open-loop manner in the first cycle of load change. Fig. 12 shows the transient response due to sudden changes in the load. From the results, the voltage in the transient response has significant improvement. The figure shows that the system exhibits very fast dynamic response with excellent load voltage regulation, indicating that the control scheme ensures a “stiff” load voltage.



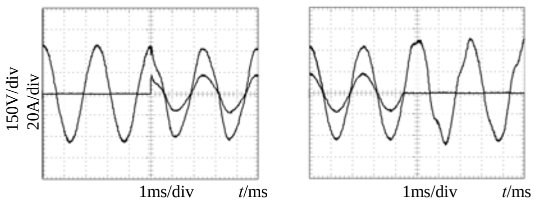
(a) SPWM control



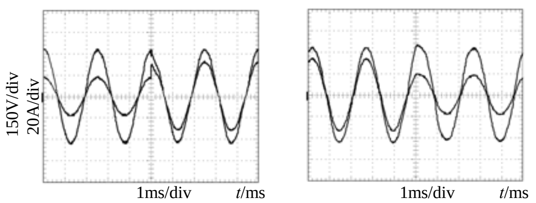
(b) Repetitive PD control

图 11　带整流型负载时的实验波形

Fig. 11　Experimental response under rectifier load



(a) 0→50% of the load　　(b) 50%→0 of the load



(c) 50%→100% of the load　　(b) 100%→50% of the load

图 12　负载阶跃变化时的实验波形

Fig. 12　Experimental response under step resistive load change

5　CONCLUSION

This paper describes a novel fuzzy-repetitive control scheme for 400Hz CVCF inverter applications. The proposed scheme combines a fuzzy PD controller with a repetitive controller. The control scheme improves both accuracy of steady state response and convergent rate of transient response. It is implemented using a TI TMS320F240 DSP. Simulation and experimental results show that the proposed control scheme is capable of supplying both linear and nonlinear loads with excellent voltage regulation and minimum distortion in the load voltage.

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