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[摘要]

[关键词]

[中图分类号] P258 [文献标识码] A [文章编号] 1674-5019-2018-02-0089-04

The Modified Grey Prediction Model and Its Application in Deformation Monitoring

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1 前言

2 GM (1, 1) 模型^[5]

GM 1 1

Gray Model 1 1

$$X^{(0)} = (x^{(0)}(1), x^{(0)}(2), \dots, x^{(0)}(n)) \quad 1$$

1-AGO accumulated generating operation

$$X^{(1)} = (x^{(1)}(1), x^{(1)}(2), \dots, x^{(1)}(n)) \quad 2$$

[2]

[6-7]

[1][3-4]

[6]

$$X^{(1)}(k) = \sum_{i=1}^k x^{(0)}(i), k=1,2,\dots,n$$

GM 1 1

$$x^{(0)}(k) + a \cdot z^{(1)}(k) = b \quad 3$$

$$x^{(0)}(k) \quad a \quad b$$

$$B = \begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -z^{(1)}(n) & 1 \end{bmatrix} \quad Y = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(n) \end{bmatrix}$$

$$z^{(1)}(k) = \alpha \cdot x^{(1)}(k) + (1-\alpha) \cdot x^{(1)}(k-1), k=2,\dots,n \quad X^{(1)}$$

$$\begin{bmatrix} a \\ b \end{bmatrix} = [B^T B]^{-1} B^T Y$$

$$\frac{dx^{(1)}}{dt} + a \cdot x^{(1)} = b \quad 4$$

$$x^{(1)}(t) = \left(x^{(1)}(1) - \frac{b}{a} \right) e^{-at} + \frac{b}{a} \quad 5$$

IAGO

$$\hat{x}^{(0)}(k+1) = (1-e^a) \left(x^{(0)}(1) - \frac{b}{a} \right) e^{-ak} + \frac{b}{a} \quad (k=1,2,3,\dots,n) \quad 6$$

3 灰色预测模型的改进

$$\rho(k) \quad X^{(0)}$$

$$\rho(k) = \frac{x^{(0)}(k)}{\sum_{i=1}^{k-1} x^{(0)}(i)} \quad (k=2,3,\dots,n) \quad 7$$

GM 1 1

[4]

[4]

GM 1 1

GM 1 1

MSE

AME

MAPE

MSE

$$MSE = \frac{1}{n} \sum_{k=1}^n (X^{(0)}(k) - \hat{X}^{(0)}(k))^2 \quad (k=1,2,\dots,n) \quad 8$$

3 1

[1]

GM 1 1

$$m^{-X^{(0)}} \quad (m>1) \quad X_1^{(0)} \quad [1] \quad X_1^{(0)} = e \quad m$$

$$X_1^{(0)} \quad \hat{X}_1^{(0)} \quad \hat{X}^{(0)} = -\log_m^{-\hat{X}_1^{(0)}}$$

3 2

[4]

X₂⁽⁰⁾

GM 1 1

$$q \left(p < 0, pX^{(0)} + q > 0 \right) \quad X_2^{(0)} = pX^{(0)} + \frac{q}{p} \quad [4]$$

$$X_2^{(0)} \quad \hat{X}_2^{(0)} \quad \hat{X}^{(0)} = \frac{[\hat{X}_2^{(0)} - q]}{p}$$

X⁽⁰⁾

4 实验分析

3

2017 8 8

GM 1 1

2

1 2 3

1 2 3

4

1 2 3

Q 17mm 1.11mm -Q 43mm

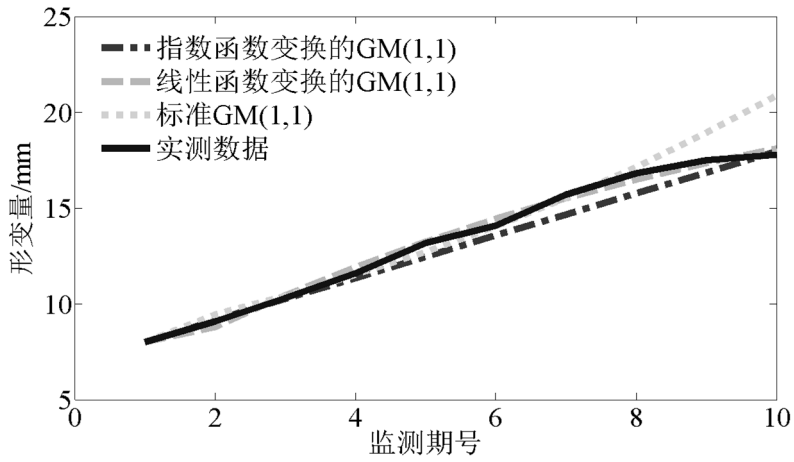
Q 32mm

1.53mm 1.01mm 4

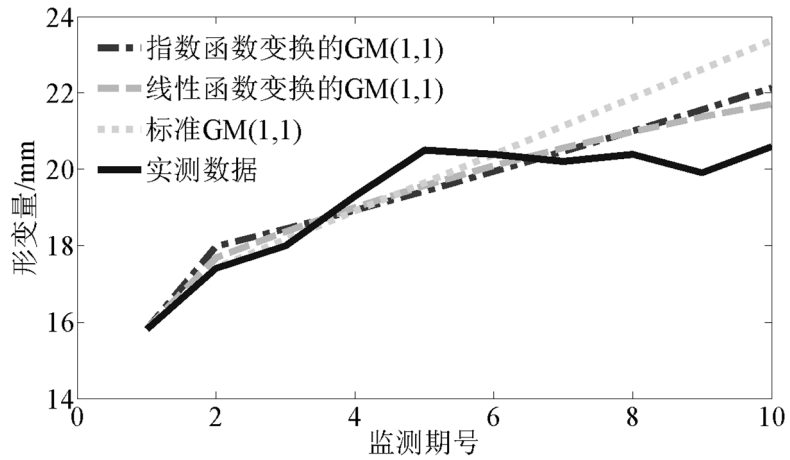
MSE

Q 0601mm

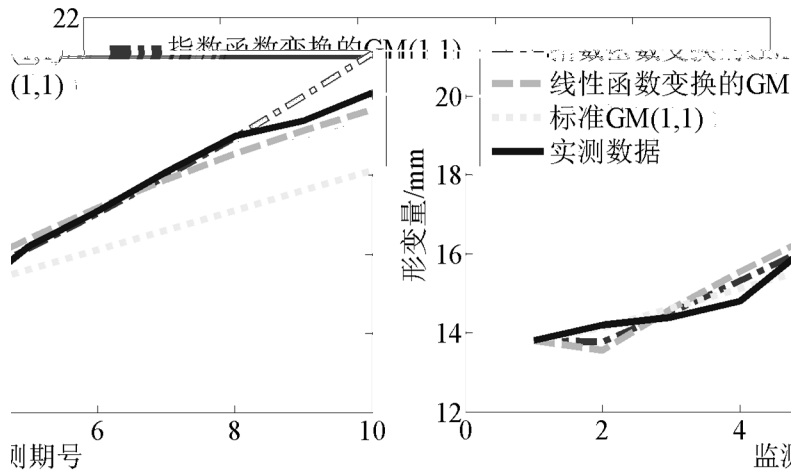
Q 5133mm Q 1558mm



1



2



3

	1	2	3	4	5	6	7	8	9	10
GM(1,1)	0	0.34	0.12	-0.09	-0.48	-0.06	-0.19	0.33	1.42	3.10
	0	0.06	-0.04	-0.24	-0.74	-0.54	-1.03	-1.03	-0.63	0.32
	0	-0.32	0.13	0.31	0.05	0.34	-0.19	-0.32	-0.15	0.17

	2		mm							
	1	2	3	4	5	6	7	8	9	10
GM 1 1	0	0.01	0.16	-0.40	-0.85	-0.01	0.94	1.48	2.73	2.77
