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1.

16

208

$$A_{ij} = - \int_{I_i} \frac{\nabla \phi_i}{I_i} \cdot \frac{\nabla \phi_j}{I_j} dx dy, \quad A_{ij} = \int_{I_i} \int_{I_j} \nabla \phi_i \cdot \nabla \phi_j dx dy,$$

$$\Delta b = \frac{df(\sigma)}{d\sigma} \cdot \Delta \sigma,$$

g

$$F(g) = \frac{\lambda}{2} \|Ag - b\|_2^2 + \alpha_1 \|\nabla g - v\|_1 + \alpha_0 \|\varepsilon(v)\|_1,$$

$$\frac{1}{2} \|Ag - b\|_2^2$$

$$\bar{g} = \arg \min_g F(g);$$

$$\bar{g} = \arg \min_g F(g)$$

$$\min_{g,v} \max_{p \in P, q \in Q} \langle \nabla g - v, p \rangle + \langle \varepsilon(v), q \rangle + \frac{\lambda}{2} \|Ag - b\|_2^2,$$

$$P = \{p = (p_1, p_2) \mid \|p\|_1 = 1\}, \quad Q = \{q = (q_{11}, q_{12}, q_{21}, q_{22}) \mid \|q\|_\infty \leq \alpha_0\};$$

$$\bar{g} = \arg \min_g F(g)$$

W

9)

 $g^{k+1} v^{k+1}$

g

[0001]

[0002]

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[0004]

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[0005]

[0006]

Ti khonov

[0007]

Ag b A b g

[0008] $F(g) = \frac{\lambda}{2} \|Ag - b\|_2^2 + \alpha_1 \|\nabla g - v\|_1 + \alpha_0 \|\varepsilon(v)\|_1$

[0009] $(\alpha_1 \|\nabla g - v\|_1 + \alpha_0 \|\varepsilon(v)\|_1) + \frac{\lambda}{2} \|Ag - b\|_2^2$ ()

[0010]

[0011] $\bar{g} = \arg \min_g F(g)$

[0012]

[0013]

[0014] 1. b A b₁ b₂

[0015] 2. , Ag b

[0016] 3.

[0017] 4. $\bar{g} = \arg \min_g F(g)$

[0018] 5. $\bar{g} = \arg \min_g F(g)$,

[0019] 6.

[0020]

Ti khonov

Ti khonov

[0021] 1

[0022] 2

[0023] 3

Ti khonov

[0024] 4

(Relative Error RE)

(Correlation Coefficient CC)

[0025] 5(a)

RE CC (b)

RE CC

[0026] 1

2

3

4

5

[0027]

[0028]

[0029] 1

[0030] 2

16 5

2

1

3

4

[0031] 3

Ti khonov

((d) (f))

((a) (c))
Ti khonov

Ti khonov

Ti khonov

[0032]

$$\min_g \{F(g)\} = \min_g \left\{ \|Ag - b\|_2^2 \right\} \quad F(g)$$

F (g)

$$F(g) = \frac{1}{2} \|Ag - b\|_2^2 + \lambda \|g\|_2^2$$

$$\|Ag - b\|_2^2$$

R(g)

[0033]

Ti khonov

Ti khonov

$$F(g) = \frac{1}{2} \|Ag - b\|_2^2 + \lambda \|g\|_2^2$$

L_2

[0034]

$$F(g) = \frac{1}{2} \|Ag - b\|_2^2 + \lambda \int_{\Omega} |\nabla g| dx$$

L_1

[0035]

[0036]

16

208

b_2 b b_1 b_2

b_1

[0037]

A

$$A_{ij} = - \int \frac{\nabla \phi_i}{I_i} \cdot \frac{\nabla \phi_j}{I_j} dx dy$$

A_{ij} j

i

i i

I_i

j j

I_j

i j

[0038]

f () b

f ()

b

$$\Delta b = \frac{df(\sigma)}{d\sigma} \cdot \Delta \sigma ,$$

b

Ag b g

[0039]

$$F(g) = \frac{\lambda}{2} \|Ag - b\|_2^2 + \alpha_1 \|\nabla g - v\|_1 + \alpha_0 \|\varepsilon(v)\|_1$$

$\alpha_1 \|\nabla g - v\|_1$

$\|v\|_1$

1 0

$$\frac{1}{2} \|Ag - b\|_2^2$$

$\bar{g} = \arg \min_g F(g) .$

[0040] $\bar{g}_\lambda = \arg \min_g F(g_\lambda) ; \min_{g,v,p \in P, q \in Q} \langle \nabla g - v, p \rangle + \langle \varepsilon(v), q \rangle + \frac{\lambda}{2} \|Ag - b\|_2^2$

P = {p = (p1, p2) | ||p|| = 1} Q = {q = (q11, q12, q21, q22) | ||q||_∞ ≤ α0} .

[0041] $\bar{g} = \arg \min_g F(g)$

[0042] 1) w 0, v 0, v̄ = 0, p = 0, p̄ = 0, q 0, g0 0, 1/L, 1/L

[0043] 2) $\bar{p}^{k+1} = \text{proj}_P(\bar{p}^k + \sigma(\nabla \bar{p}^k - \bar{p}^k)) ;$

[0044] 3) $\bar{q}^{k+1} = \text{proj}_Q(\bar{q}^k + \sigma(\varepsilon(\bar{v}^k))) ;$

[0045] 4) $w^{k+1} = \text{prox}^\sigma(w^k + \sigma(A\bar{g}^k - b)) ;$

[0046] 5) $g^{k+1} = g^k + \tau(\text{div} \nabla p^{k+1} - A^T w^{k+1}) ;$

[0047] 6) $v^{k+1} = v^k + (p^{k+1} + \text{div} \nabla q^{k+1})$

[0048] 7) $\bar{g}^{k+1} = \text{prox}^\sigma(g^{k+1} + \sigma(A^T v^{k+1} - g^{k+1})) ;$

[0049] 8) $\bar{v}^{k+1} = 2v^{k+1} - v^k ;$

[0050] 9) $g^{k+1} = v^{k+1}$

[0051]

[0052] 3

Ti khonov

Ti khonov

Ti khonov

(1) (2) RE CC

RE CC 5

[0053] $RE = \frac{\|\sigma - \sigma^*\|_2^2}{\|\sigma^*\|_2^2} \quad (1)$

[0054] $CC = \frac{\sum_{i=1}^t (\sigma_i - \bar{\sigma})(\sigma_i^* - \bar{\sigma}^*)}{\sqrt{\sum_{i=1}^t (\sigma_i - \bar{\sigma})^2 \sum_{i=1}^t (\sigma_i^* - \bar{\sigma}^*)^2}} \quad (2)$

[0055] * t $\bar{\sigma} \bar{\sigma}^*$

* i i * i

[0056] 4 RE CC Ti khonov (a) (c)

RE CC

((d) (f)) RE CC
((a) (c))
(d) (f))

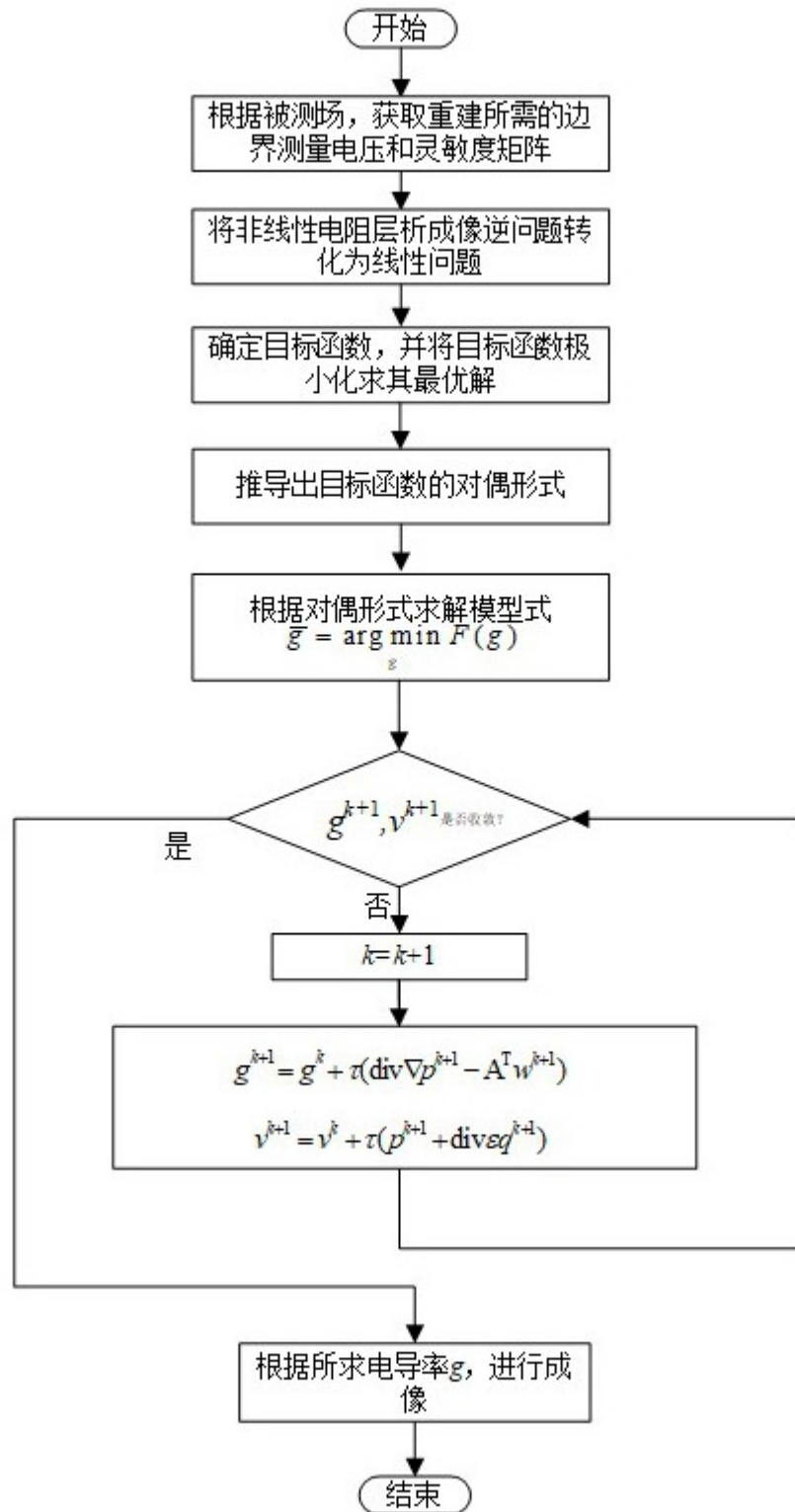
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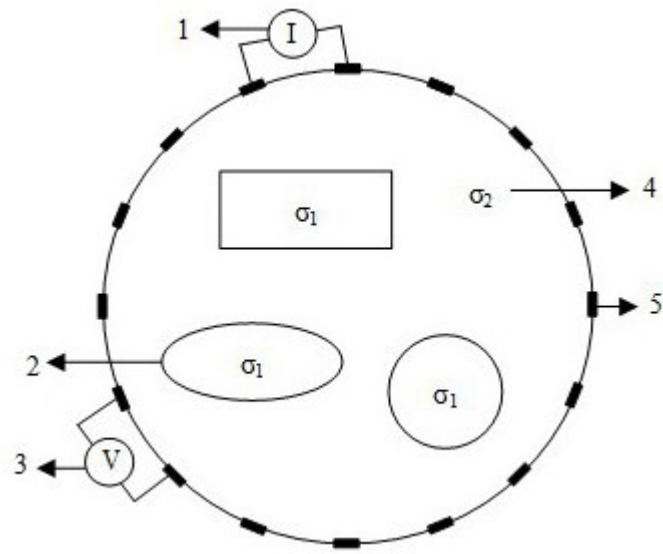
[0057]

0 2.5 5 7.5 10

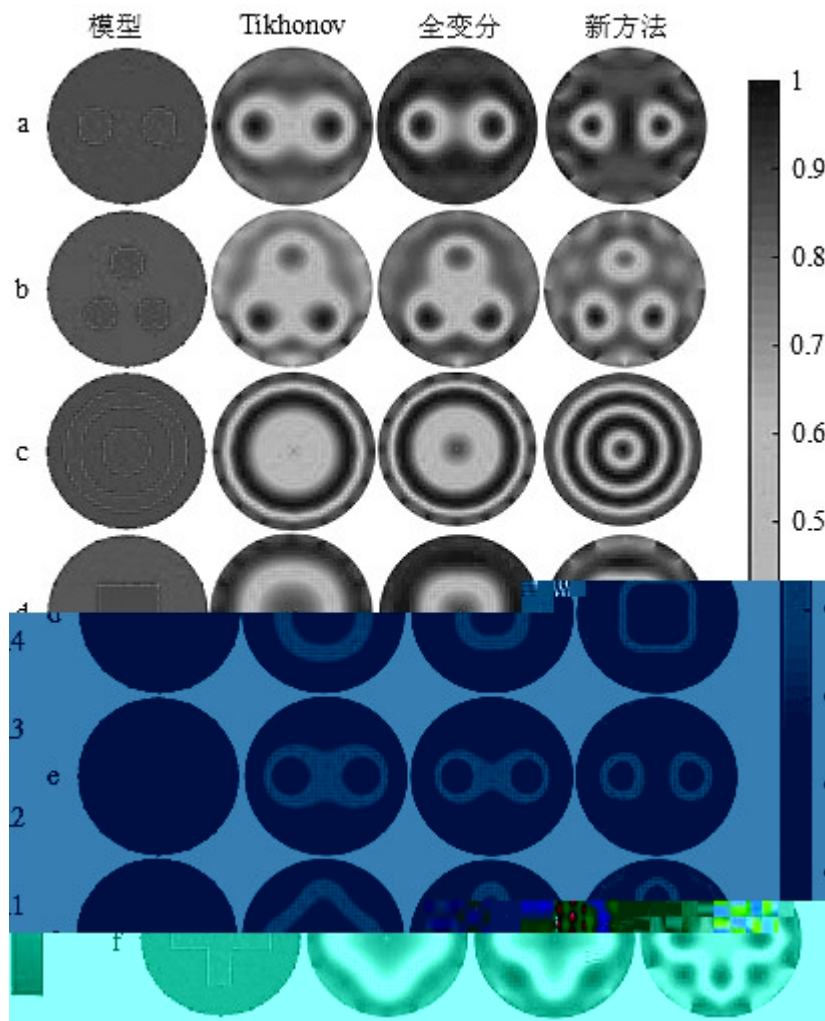
(a) (e) 5
RE CC Ti khonov
(a) 5(a) RE
CC
(e) RE CC 5(b)

[0058]

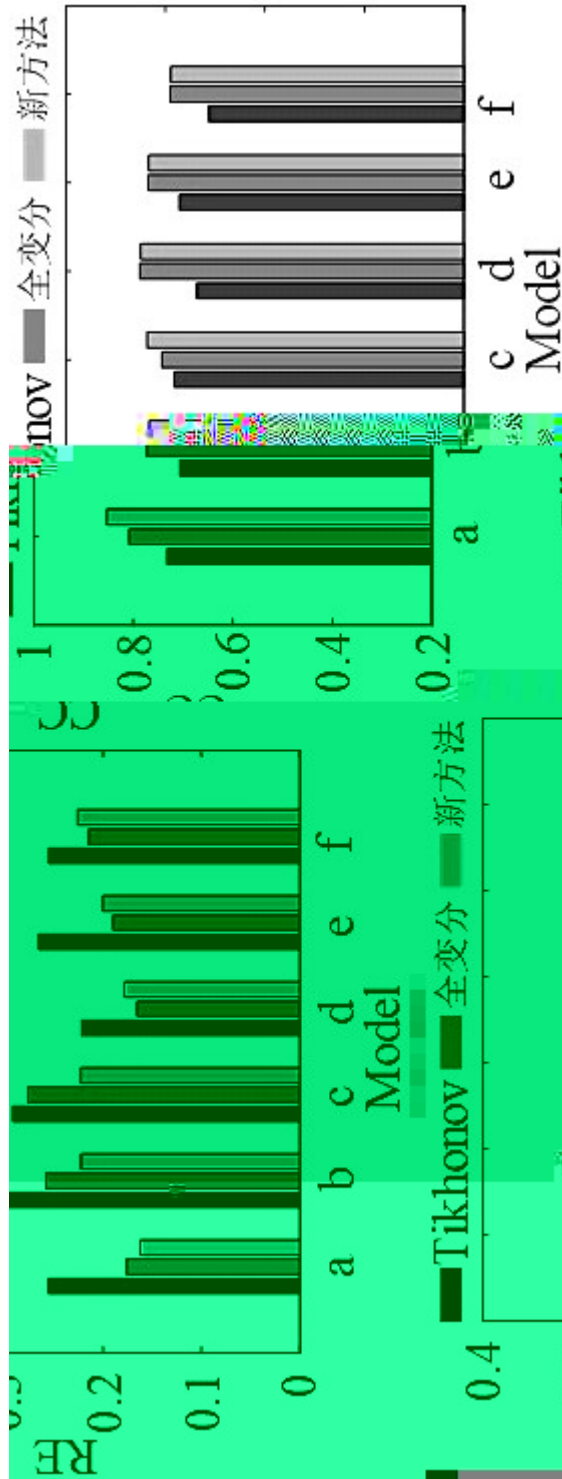


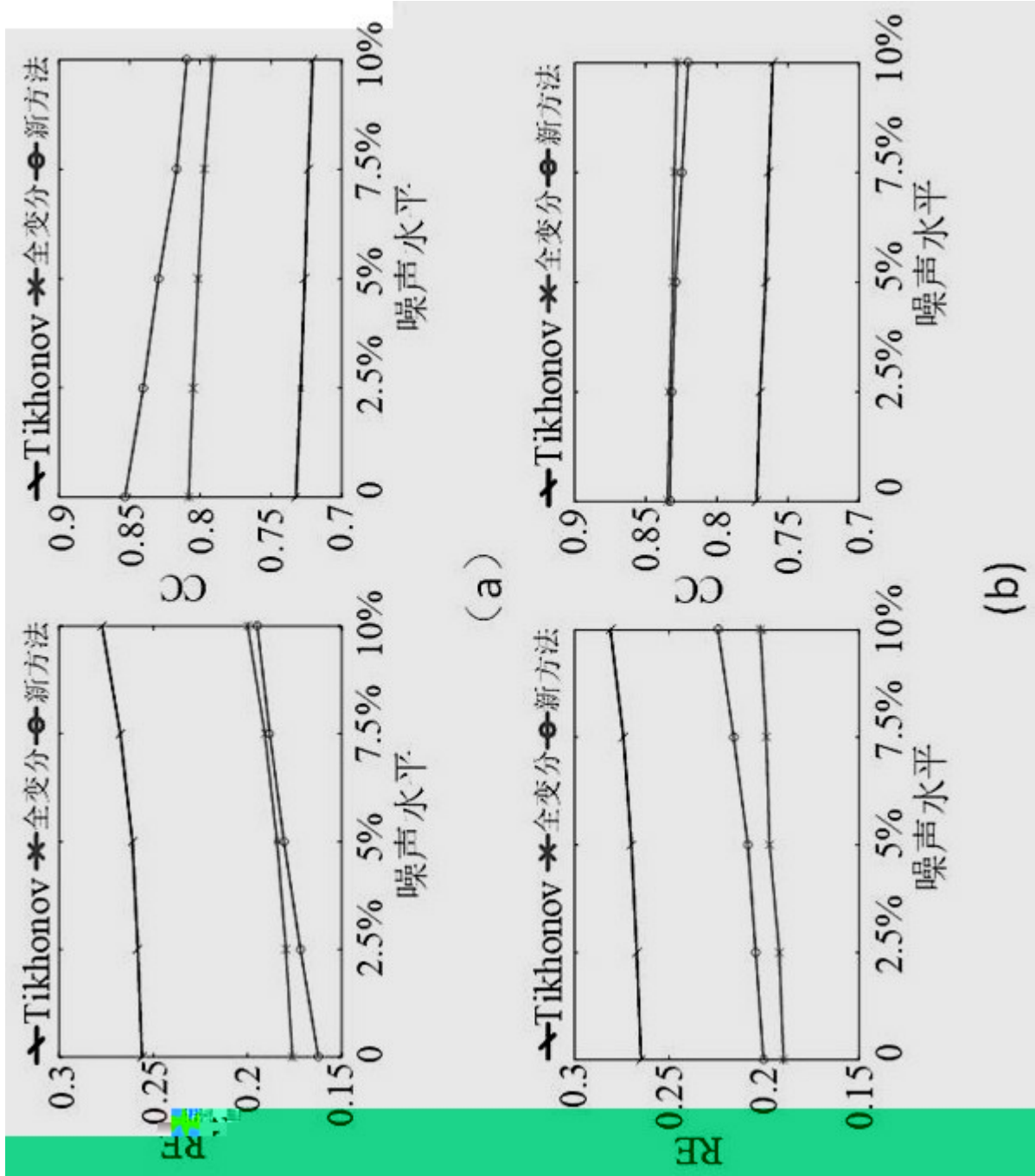


2



3





(a)

(b)