Research on Reliability of Information Push Robot Based on Image Self-learning

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Abstract: In order to improve the intelligent control ability of information push robot, an output reliability control method of information push robot based on image self-learning is proposed. The parameter identification model of robot output reliability positioning is constructed, and the pose correction and adaptive adjustment of information push robot are carried out by combining fuzzy constraint parameter control method. Adaptive learning control law is adopted to carry out adaptive feedback correction of robot spatial distribution parameter error under computer image vision, and computer image vision information tracking fusion method is adopted to realize adaptive positioning and fuzzy control of information push robot, and improve the ability of pose correction and error feedback adjustment. The simulation results show that the output reliability control accuracy of the information push robot is high and the adaptive control ability is good.

1. Introduction

With the development of intelligent industrial machinery technology, information push robots are widely used in artificial intelligence manufacturing and mechanical operation. In the design and application of information push robots, the adaptive positioning performance of information push robots is not good due to factors such as mechanical components and environmental information disturbance. It is necessary to construct the intelligent control algorithm and positioning model of information push robot, analyze the control constraints of information push robot, and combine the optimized control law and parameter identification method to realize the optimal positioning and posture correction of information push robot, so as to improve the automatic control level of information push robot[1].

The output reliability control of the information push robot is based on the pose parameter correction and fusion sensing tracking recognition of the information push robot, constructs the constraint parameter model of the output reliability control of the information push robot, and adopts the corresponding adaptive control algorithm to realize the output reliability control and optimization design of the information push robot. The output reliability control methods of information push robot mainly include fuzzy control method, point tracking identification method and PID control method, etc[2-4]. Combining with the pose parameter identification of information push robot, the output
reliability control and information fusion processing of information push robot are carried out. However, the environmental adaptability and disturbance resistance of traditional methods for output reliability control of information push robot are not good. To solve the above problems, this paper proposes an output reliability control method of information push robot based on image self-learning. The adaptive positioning and fuzzy control of the information push robot is realized. Finally, the simulation test analysis shows the superior performance of this method in improving the output reliability control ability of information push robot.

2. Constraint parameters and kinematics analysis of output reliability control of industrial information push robot

2.1. Output reliability control constraint parameters of information push robot

In order to realize the output reliability control of information push robot based on image self-learning, firstly, the parameter identification model of output reliability positioning of information push robot is constructed, then the motion path of target position is planned and designed by combining the fuzzy constraint parameter control method, and the position and posture measurement model of driving end of information push robot is constructed by combining the method of information transmission success rate evaluation[5]. A wavelet recurrent neural network measurement model for output reliability control of information push robot is obtained. The horizontal displacement of the driving end of information push robot is obtained by taking the rod centroid as the measurement object, and the reaction moment of information push robot is input, which is substituted into the driving transfer parameter control model of information push robot to obtain the output torque. Based on the centroid height control method of energy compensation, the state estimation parameter of output reliability positioning of information push robot is obtained, and the covariance matrix of output reliability control of information push robot is obtained. Calculate the forward kinematics model of output reliability control of information push robot at time, and get the fuzzy state parameters of attitude control as follows:

\[ \Lambda_j(k) = P(z(k) / m_j(k), z^{k+1}) = P(z(k) / m_j(k), \dot{z}^{k+1} (k - 1 / k - 1), P^0(k - 1 / k - 1)) = N((z'(k) - z'(k / k - 1)) | 0, S'(k)) \]  

Here, \( \Lambda_j(k) \) obeys the high-order statistical state distribution with mean value of 0 and variance of 0, \( DF \) is the moment of inertia of the information push robot, and the tracking torque of the output reliability control of the information push robot is described as \( m_j (j = 1, 2, \cdots, m) \) \( \forall m_j \in M \). The optimal motion state parameters of the information push robot are found through kinematic modeling, and the pose positioning feature components of the information push robot are constructed between coordinate systems \( i^{-1}T_i(q_i) \) and \( i-1 \). The uniformity of pose positioning parameter distribution of the information push robot is obtained by using the fuzzy rotation control method:
The 4×4 homogeneous coordinate matrix can be used to represent the driving mechanical parameter model of the information push robot $^tT_0(\alpha_0, \beta_0, \gamma_0)$, and the parameter identification model of the output reliability positioning of the information push robot is constructed, and the pose of the information push robot is corrected by combining the fuzzy constraint parameter control method to improve the driving control accuracy of the information push robot[6].

### 2.2 Kinematics model of information push robot

Adaptive learning control law is used to correct the spatial distribution parameter error of information push robot under computer image vision[7]. According to the above analysis, the optimal control law of output reliability control of information push robot is obtained by using computer image vision information tracking fusion method:

$$j(k|k-1) = \hat{y}(k|k-1) \hat{x}(k|k-1)$$

$$= [I - F(k-1)\{F(k-1) + Q^{-1}(k-1)\}]^{\top}$$

$$\times F(k-1)\Phi(k-1)\hat{x}(k-1|k-1) + J(k-1)\hat{M}(k-1)]$$

$$= [I - F(k-1)\{F(k-1) + Q^{-1}(k-1)\}]^{\top}\lambda^{-1}(k)$$

$$\times [\Phi^{-1}(k-1)^{\top}y(k-1|k-1)\hat{x}(k-1|k-1)$$

$$+ \Phi^{-1}(k-1)^{\top}J(k-1)\hat{M}(k-1)]$$

$$= \lambda^{-1}(k)[I - F(k-1)\{F(k-1) + Q^{-1}(k-1)\}]^{\top}$$

$$\times [\Phi^{-1}(k-1)^{\top}[\hat{y}(k-1|k-1) + \hat{i}(k-1)]$$

Wherein, $\hat{i}(k-1) = Y(k-1|k-1)\Phi^{-1}(k-1)J(k-1)\hat{M}(k-1)$. According to the analysis results of phase dynamic model parameters, the position and orientation output of the information push robot is obtained as follows:

$$k(k) = P(k|k-1)\bar{H}^T(k)[\bar{H}(k)\Phi(k|k-1)\bar{H}^T(k) + R(k)]^{-1}$$

$$= P(k|k-1)\bar{H}^T(k)\{[\bar{H}(k)\Phi(k|k-1)\bar{H}^T(k) + R(k)]^{-1}$$

$$+ R^{-1}(k) - R^{-1}(k)\}$$

$$= P(k|k-1)\bar{H}^T(k)\bar{R}^{-1}(k) + P(k|k-1)\bar{H}^T(k)$$

$$\times [\bar{H}(k)\Phi(k|k-1)\bar{H}^T(k) + R(k)]^{-1}$$

$$\times [I - [\bar{H}(k)\Phi(k|k-1)\bar{H}^T(k) + R(k)]\bar{R}^{-1}(k)]$$

$$= (P(k|k-1) + P(k|k-1)\bar{H}^T(k)$$

$$\times [\bar{H}(k)\Phi(k|k-1)\bar{H}^T(k) + R(k)]^{-1}$$

$$\times \bar{H}(k)\Phi(k|k-1)\bar{H}^T(k)R^{-1}(k)$$

$$= P(k|k)\bar{H}^T(k)R^{-1}(k)$$

The adaptive positioning and fuzzy control of the information push robot are realized by using the computer image visual information tracking fusion method, and the ability of posture correction and
Error feedback adjustment of the information push robot is improved. According to the feedback control principle, the output periodic solution is obtained as follows:

\[
\begin{align*}
F(k-1) &= \lambda_i(k)[\Phi^{-1}(k-1)]^T Y(k-1) |k-1) \Phi^{-1}(k-1) \\
\hat{\xi}(k-1) &= Y(k-1) |k-1) \Phi^{-1}(k-1) \mathbf{J}(k-1) \mathbf{M}(k-1)
\end{align*}
\]  

(5)

According to the above analysis, the error feedback correction problem of constructing the output reliability control of the information push robot can be expressed as:

\[
\begin{align*}
\min F &= R^2 + A \sum \xi_i^2 \\
st : &\| \phi(x_i) - o \| \leq R^2 + \xi_i^2 \text{ and } \xi_i \geq 0, i = 1,2,\ldots \\
\max \sum a_i K(x_i, x_j) &= \sum a_i K(x_i, x_j) \\
st : &\sum a_i = 1 \text{ and } 0 \leq a_i \leq A, i = 1,2,\ldots
\end{align*}
\]  

(6)

Combined with the method of constructing kinematic parameter model of rotation and translation, the fuzzy control parameter model of output reliability control of information push robot under computer image vision is obtained[8].

3. Optimization of output reliability control model of information push robot

3.1. adaptive learning control law

Under the computer image vision, the adaptive learning control law is adopted to carry out adaptive feedback correction on the spatial distribution parameter error of the information push robot, and the kinematic characteristic analytical model of the information push robot is established[9], and the independent variable parameter constraint planning matrix for the output reliability control of the information push robot is obtained as follows:

\[
\begin{bmatrix}
\mathbf{c}_i & -\mathbf{c}_a & \mathbf{s}_a & \mathbf{s}_i & \mathbf{a}_c & \mathbf{c}_i \\
\mathbf{s}_i & \mathbf{c}_a & \mathbf{c}_i & \mathbf{s}_a & \mathbf{a}_s & \mathbf{s}_i \\
0 & \mathbf{s}_a & \mathbf{c}_a & \mathbf{d}_i & 0 & 0
\end{bmatrix}
\]  

(8)

Assuming that the information push robot moves randomly in all directions step by step, the position \((\mathbf{q}(k)) = \mathbf{T}(\mathbf{q})\) of the information push robot can be expressed by a 4×4 homogeneous coordinate matrix in the child node of the previous pose. According to the pose positioning characteristics of the information push robot, the path disturbance factors from the initial node to the target node are analyzed, and the parameter fusion model of the information push robot is described as follows:

\[
\begin{align*}
x(k+1) &= A x(k) + B u(k) \\
z(k) &= C x(k)
\end{align*}
\]  

(9)

Wherein, \(x(k) \in \mathbb{R}^r\) represents the extension range of information push robot, normal vector of information transmission point, analyzes the correlation between normal vector of information push robot feature distribution point and orientation vector of information push robot, and outputs it with
the probability density representing the success of information push robot transmission, which is the pose information of information transmission of information push robot, and the seed point at the starting position of information push robot chassis is a positive integer \(10\). The fuzzy motion control parameter set of connecting rod, which represents the overall rotation direction of each joint of the industrial information push robot and makes the joints of the information push robot drive freely, is, and is respectively recorded as \(u(k) \in R^r\) and \(q_1 = [q_1, ..., q_l]^T\), and is abbreviated as \(\sin q_i\) and \(\sin q_l\). The tracking amount of sensing information controlled by the information push robot output reliability is:

\[
\begin{align*}
\psi_{i,j}(k) &= P(m_j(k) / z^k) \\
&= \frac{1}{c} P(z(k) / m_j(k), z^{k+1})P(m_j(k) / z^{k+1}) \\
&= \frac{1}{c} \Lambda_i(k) \bar{c}_j
\end{align*}
\]

In the two-degree-of-freedom linkage formula, the partial differential equation of output reliability control of information push robot is obtained:

\[
\begin{align*}
V_1(x(t)) &= 2x^T(t)PAx(t) + 2x^T(t)PBx(t) - (1 - \tau)x^T(t - d(t))Q_7x(t - d(t)) \\
&\quad + x^T(t)Q_7x(t) - (1 - \tau)x^T(t - d(t))(Q_7 - Q_2)x(t - d(t)), \\
V_2(x(t)) &= x^T(t)(R_1 + R_2)x(t) - x^T(t - h_1)R_1x(t - h_1) - x^T(t - h_1)R_2x(t - h_1), \\
V_3(x(t)) &= \dot{x}^T(t)(h_1Z_1 + h_2Z_2 + h_3Z_3)\dot{x}(t) - \int_{-\infty}^{t} \dot{x}^T(s)Z_1\dot{x}(s)ds \\
&\quad - \int_{-\infty}^{h_1} \dot{x}^T(s)Z_1\dot{x}(s)ds - \int_{-\infty}^{t} \dot{x}^T(s)Z_2\dot{x}(s)ds.
\end{align*}
\]

It is noted that \(K(Z_1 + Z_2 + Z_3)^T, W, M\) is the initial spring mechanics matrix sum in \(0 \leq d(t) \leq h_1\), and the fuzzy visual tracking method is adopted to design the output reliability control law of the information push robot.

### 3.2 Position and Position Output of Information Push Robot Terminal

Under computer image vision, adaptive learning control law is adopted to carry out adaptive feedback correction of spatial distribution parameter error of information push robot, and the analytical model of kinematic characteristics of information push robot is established [9], and the state feature quantity of equation sum is obtained. In the motion planning area \(0 \leq d(t) \leq h_1\) of information push robot, the method of secondary kernel space fusion is adopted, and the joint control state equation of output reliability control of information push robot is satisfied if and only if:

\[
\begin{align*}
\Psi(h_1, h_2) &= \Psi + h_1K(Z_1 + Z_2 + Z_3)^T + h_2M(Z_2 + Z_3)^T < 0, \\
\Psi(h_1, 0) &= \Psi + h_1K(Z_1 + Z_2 + Z_3)^T + h_2L(Z_2 + Z_3)^T < 0, \\
\Psi(0, h_1) &= \Psi + h_1WZ_1^T + h_2L(Z_2 + Z_3)^T + h_3L(Z_2 + Z_3)^T < 0, \\
\Psi(0, 0) &= \Psi + h_1WZ_1^T + h_2L(Z_2 + Z_3)^T + h_3L(Z_2 + Z_3)^T < 0.
\end{align*}
\]
In the horizontal direction, the motion state feature quantity of the information push robot is analyzed, and the positioning pose of the information push robot is optimally estimated by using the method of joint error feedback, so that the estimated value of pose parameter is \( \hat{x}(k|k) \), and its polynomial kernel function covariance matrix \( P(k|k) \) is obtained. Through computer image visual tracking, the fuzzy iterative formula for output reliability control of the information push robot is obtained:

\[
\hat{x}(k|k-1) = \Phi(k-1)\hat{x}(k-1|k-1) + J(k-1)M(k-1)
\]

(18)

\[
P(k|k-1) = \lambda(k)\Phi(k-1)P(k-1|k-1)\Phi^T(k-1) + \mathbf{Q}(k-1)
\]

(19)

\[
K(k) = P(k|k-1)\mathbf{H}^T(k)[\mathbf{H}(k)P(k|k-1)\mathbf{H}^T(k) + R(k)]^{-1}
\]

(20)

\[
\hat{x}(k|k) = \hat{x}(k|k-1) + K(k)[M(k) - \mathbf{H}(k)\hat{x}(k|k-1)]
\]

(21)

\[
P(k|k) = [I - K(k)\mathbf{H}(k)]P(k|k-1)
\]

(22)

In which \( I \) represents \( n \)-order covariance identity matrix. Analyze the state matrices \( P \in \mathbb{R}^{n \times n} \), \( R \in \mathbb{R}^{m \times m} \) and \( H \in \mathbb{R}^{m \times n} \) of output reliability control of information push robot, identity matrix \( I \in \mathbb{R}^{n \times n} \); The forward speed control parameters of output reliability control of information push robot are analyzed, and the state functional of \( P^{-1} + H^T R^{-1} H \) sum exists, and the fuzzy kernel space state parameters of output reliability control of information push robot are obtained:

\[
[I + PH^T R^{-1} H]^{-1} P = [P^{-1} + H^T R^{-1} H]^{-1}
\]

(23)

\[
= P - PH^T (HPH^T + R)^{-1} HP
\]

The analytical model of kinematic characteristics of information push robot is established. Under the motion coordinate system, the obtained quantity changes linearly, which is expressed as \( \sigma 7 \). The driving control of information push robot is carried out by combining the distributed sensor positioning, tracking and identification method. Under the adjustment of pose parameters, \( \sigma 0 \), the measurement model of pose parameters of information push robot is expressed as:

\[
^0 T_1(q_i) = \prod_{i=1}^{T} \frac{\pi}{i} T_1(q_i) = \left[ \begin{array}{ccc} n & o & a \\ 0 & 0 & 1 \end{array} \right]
\]

(24)

In the step-by-step action space coordinate system, the kinematic modeling parameter model of the information push robot is obtained as follows:

\[
q_1 \equiv \Theta_4 = \text{atan2}(\pm p_{4x}, \pm p_{4z})
\]

(25)

\[
q_2 \equiv \Theta_2 = \text{atan2}(c_1 p_{4z} + s_1 p_{4y}, -l_z)
\]

(26)

he feedback constraint parameters of information transmission posture of information push robot are constructed, and the constraint parameter model and control objective function of output reliability
control of information push robot are obtained by combining fuzzy decoupling control method, and the sum is obtained:

\[ q_3 = \text{atan2}( -s_1o_4 + c_1o_4 + s_2c_1o_4 - s_2s_1o_4 - c_2o_4 ) \] (27)

\[ q_4 = \theta_1 = \text{atan2} \left( c_2c_1n_4 + c_2s_1n_4 + s_2n_4 \right) \] (28)

By analogy, the positioning attenuation parameter model of the information push robot is obtained, and the Doppler velocity measurement model of the information push robot is constructed in the 7-degree-of-freedom space, and the fuzzy control parameter model under computer image vision is described as follows:

\[ 4T^{-1}(q_i) \cdot 4T_i = \prod_{i=0}^{7} T_i(q_i) \] (29)

The above formula is equivalent to the reliability parameter model of information push robot operation. According to the above algorithm design, the accurate output reliability control of information push robot is realized.

4. Simulation test analysis

The application performance of this method in realizing output reliability control of information push robot is tested by simulation experiment, and the visual tracking recognition of output reliability control of information push robot is carried out under the image adaptive learning vision. The information push robot adopts HIR industrial information push robot, and the number of data sampling samples in the information transmission process is set to 1200, the test set is set to 247, the distribution of negative sample set is 1034, the iteration steps of output reliability control of information push robot are 240, the dimension of control parameters is 26, and the information push robot runs.

![Fig. 1 Running track of information push robot](image-url)

Output reliability control of information push robot is carried out under computer image vision, and the visual positioning result is shown in Figure 2.
By analyzing Figure 2, we know that this method can track the visual positioning ability of information push robot, and get the control convergence curve as shown in Figure 3.

![Fig. 2 Visual positioning results of information push robot](image)

![Fig. 3 Control convergence curve](image)

By analyzing Figure 3, we know that the convergence of output reliability control of information push robot by this method is good, and the comparison results obtained by testing positioning accuracy are shown in Table 1. By analyzing Table 1, we know that the output reliability control accuracy of industrial information push robot by this method is higher.

| Iterations | This method | BP   | Integral control |
|------------|-------------|------|------------------|
| 100        | 0.935       | 0.856| 0.847            |
| 200        | 0.969       | 0.879| 0.868            |
| 300        | 0.996       | 0.911| 0.917            |
| 400        | 1           | 0.923| 0.926            |
5. Conclusions
The intelligent control algorithm and output reliability transmission control model of information push robot are constructed, and the control constraints of information push robot are analyzed. This paper proposes an output reliability control method of information push robot based on image self-learning. The fuzzy control parameter model of output reliability control of information push robot under computer image vision is obtained by combining the construction method of rotation and translation kinematics parameter model. The analytical model of kinematics characteristics of information push robot is established, and the adaptive positioning and fuzzy control of information push robot are realized by using computer image visual information tracking and fusion method, so as to improve the posture correction and error feedback adjustment ability of information push robot. The research shows that this method has higher accuracy and better convergence for visual positioning of information push robot.

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