An optimal algorithm analysis of signal transitive random signal without noise feedback

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Abstract. This article used the way of stochastic processes statistics to raise and study a kind of optimization of signal transitive stochastic system without noise feedback, and it did the optimum operation to permit coding function of the signal and solved the measuring question of the optimum coding and decoding of the signal. It could contributs an ideal way of mathematical.

1. Introduction
Facts show how effective filtering information and information processing and analysis, for improving the signal transfer system and the efficiency of decision-making information play a crucial role [1-4]. The forecast of the gross industrial production in the industrial production is of great significant. The forecast can guide national policy direction for industrial development, in order to adopt appropriate strategies and measures to maximize the development. As far as we concerned, there are several factors related to the Gross industrial production, including the natural resources, human resources, economic development level. Though several other methods, which is the deterministic method and the time-series method, can be used in the forecasting of the gross industrial production, the Gray Forecast Model has its unique advantages, such as its relatively simple Principles, less restrictive data requirements, not fatigue errors during the calculation of the data, and higher accuracy of the results, etc. In this conclusion, the Gray Forecast Model, which can not only be used in the short to medium term forecasts, but also be used in the long-term forecasts, has a more remarkable prediction precision compared with other traditional methods [5-8].

2. Information search and big data analysis
For a kind of fractional rational spectral density, several generalized stochastic process can be observed signal transfer system \( W(t), t = 0, \pm 1, \pm 2, \cdots \), and its spectral representation formula

\[
W(t) = \int_{-\pi}^{\pi} e^{i\lambda t} \frac{U_n(e^{i\lambda})}{V_n(e^{i\lambda})} \psi(d\lambda)
\]

Which is \( \psi(d\lambda) \) orthogonal random measure.

And allow spectrum of expression (1) together with the process \( W_1(t), W_2(t), \cdots, W_n(t) \), but also a new set of procedures is defined by the following formula:

\[
W_j(t) = \int_{-\pi}^{\pi} e^{i\lambda t} H_j(e^{i\lambda}) \psi(d\lambda), \quad j = 1, 2, \cdots, n
\]
Wherein the frequency characteristics $H_j(K)$, $j = 1, 2, \cdots, n$, is

$$H_j(K) = K^r(j) H_n(K) + \sum_{k=j}^{n-1} \alpha_k K^{-r(k-j+1)}, \quad j = 1, 2, \cdots, n - 1$$  \hspace{1cm} (3)

$$H_n(K) = -K^{-1} \sum_{k=0}^{n-1} \beta_k H_{k+1}(K) + K^{-1} \alpha_n$$  \hspace{1cm} (4)

and

$$\alpha_1 = \beta_{n-1}, \quad \alpha_j = \beta_{n-j} - \sum_{r=1}^{j-1} \alpha_r \beta_{n-j+r}, \quad j = 2, \cdots, n$$  \hspace{1cm} (5)

From (3), (4) can be obtained separately

$$H_j(K) = K^{-1}[H_{j+1}(K) + \alpha_j]$$  \hspace{1cm} (6)

$$H_n(K) = K^{-1}[\sum_{k=0}^{n-1} \beta_k H_{k+1}(K) + \alpha_n]$$  \hspace{1cm} (7)

It is not difficult to export

$$H_n(K) = K^{-1} \left\{ \sum_{k=0}^{n-1} \beta_k [K^{-1}\{H_{k+1}(K) + \sum_{j=k+1}^{n-1} \alpha_j K^{-1}(j-k-1)\}] + \alpha_n \right\}$$  \hspace{1cm} (8)

$$H_n(K) = \frac{U_n(K)}{V_n(K)}$$  \hspace{1cm} (9)

Which $U_n(K)$ is the order of no more than n-1 of the polynomial

From (6) to (9) may also be obtained

$$H_j(K) = \frac{U_n(K)}{V_n(K)}$$  \hspace{1cm} (10)

Wherein the order of the polynomial is not more than n-1, and in accordance in the (5)

$$U^{(n)}(K) \equiv U_{n-1}(K)$$  \hspace{1cm} (11)

So

3. Optimal algorithm analysis

We will take part in a controllable and observable process $(\xi, S) = [(\xi_1(t), \cdots, \xi_k(t)), (S_1(t), \cdots, S_k(t))]$, $0 \leq t \leq T$. Given by the following formula:

$$d\xi = [\gamma(t)u + \alpha(t)\theta, dt + \beta(t)d\varphi_1(t)$$

$$dS = \alpha(t)\varphi_1 dt + \beta(t)d\varphi_2(t)$$

(12)

Matrix $\gamma(t), \alpha(t), \beta(t), \theta(t), \phi(t)$ respectively have stage numbers $(l \times \rho), (l \times l), (l \times l), (k \times k)$. Elements $\gamma_y(t), b_y(t), a_y(t), \alpha_y(t), \beta_y(t)$ are credible time function. At the same time, for whole the allowable values $I, J$, we have

$$|\gamma_y(t)| \leq \gamma, |\alpha_y(t)| \leq \gamma, |\beta_y(t)| \leq \gamma,$$

$$\int_0^T \alpha_y^2(t) dt < \infty, \quad \int_0^T \beta_y^2(t) dt < \infty$$
Assume that elements contained in the matrix \((\beta(t)\beta^*(t))^{-1}\) keep in line with the boundary. The independent Wiener process contains (12)

\[ W_i = (W_{i1}(t), \cdots, W_{it}(t)), W_2 = (W_{21}(t), \cdots, W_{2t}(t)), 0 \leq t \leq T, \]

Gaussian vectors don't determine it \(z_0 = (Mz_0 = m_0, \text{cov}(z_0, z_0) = r_0)\) meanwhile \(S_0 = 0\).

The vector of (12) \(R_i = [R_1(t, \zeta), \cdots, R_r(t, \zeta)]\) is usually referred to as a control action at moment \(t\). \(R_j(t, \zeta), j = 1, 2, \cdots, r\) should be

\[
N \int_0^T \sum_{j=1}^r (R_j(t, \zeta)^2 dt) < \infty
\]

(13)

What can be observed is the value of \(R_j(t, \zeta) - F^t\).

Control \(R = (R_j), 0 \leq t \leq T\) (has only one strong solution in the system of equations (12), which satisfies the condition (13)) is called containable control.

In order to achieve the purpose of control, we will put loss function into study. \(W(t)\) is a uniformly symmetric positive definite matrix (order \((1 \times 1)\)). When \(M(t)\) is a symmetric nonnegative definite matrix of order \((1 \times 1)\).

Assuming the elements of the matrices \(M(t)\) and \(W(t)\) are the observable bound function of \(t\).

We study the loss function in each admissible control \(W = (W_t), 0 \leq t \leq T\).

\[
U(R;T) = N[\zeta^t h \zeta_t + \int_0^T [\zeta^t P(t) \zeta_t + u^t W(t) u] dt]
\]

(14)

\[
U(v; T) = \inf_u U(v; T)
\]

(15)

The best is containable control \(u\), and \(\inf\) is selected from all containable controls.

Below we will discuss the containable control \(u\), assuming

\[
\mu_n^u = N(\zeta, [F_i^{\xi}]), S_n^u = N((\zeta - \mu_n^u)(\zeta - \mu_n^u)^*)
\]

(16)

Where \(\Phi^\xi\) and \(\zeta^t\) are processes determined by (12), and corresponding to this control.

4. Comprehensive analysis method

Assume \(\theta_i\) and \(s, t, 0 = \pm 1, \pm 2, \cdots\), is not related to the generalized stationary sequence, and \(E\varphi_i = E\psi_i = 0\),

\[
f_\varphi(\mu) = 1/|\mu + \gamma|^2, \quad f_\psi(\mu) = 1/|\mu + \gamma|^2
\]

is the spectral density

Wherein \(|\gamma| < 1, \quad i = 1, 2\).

making \(\varphi_i\) as random desired signa, \(\xi\) as disturb, and the law of observation process is expressed as

\[
\zeta_t = \varphi + \xi_t
\]

(17)

Then we can deduce that \(E\eta_i(t) = 0, \quad E\eta_j(t)\eta_j(s) = \mu(t, s), i = 1, 2, \)

is a sequence independent of \(\varphi_i(t)\) and \(\xi_j(t), \quad t = 0, \pm 1, \pm 2, \cdots\) by formula (1), making

\[
\varphi_{r+1} = \alpha_1\varphi_i + S_1(t + 1), \xi_{r+1} = \alpha_2\xi_i + S_2(t + 1)
\]

(18)

By (17) and (18) we can obtain
\[ \zeta_{t+1} = \phi_{t+1} + \tilde{\zeta}_{t+1} = (\gamma_1 - \gamma_2) \phi_t + \gamma_2 \phi_t + S_t(t+1) + S_2(t+1) \]

So "Unobservable" process and the "observable" process to satisfy equations
\[ \phi_{t+1} = \alpha_t \phi_t + S_t(t+1) \]
\[ \zeta_{t+1} = (\gamma_1 - \gamma_2) \phi_t + \gamma_2 \phi_t + S_t(t+1) + S_2(t+1) \]  \hspace{1cm} (19)

According to (18) and (19), \( \mu_t, \ t = 0, 1, 2, \cdots \) is the best linear estimation of \( \zeta_t \), and MSE \( S_t = E(\phi_t - \mu_t)^2 \) satisfies the recursive equation
\[ \mu_{t+1} = \gamma_1 \mu_t + \frac{1 + \gamma_1 (\gamma_1 - \gamma_2) r_t}{2 + (\gamma_1 - \gamma_2)^2 r_t} [\zeta_{t+1} - (\gamma_1 - \gamma_2) \mu_t - \gamma_2 \phi_t] \]  \hspace{1cm} (20)
\[ S_{t+1} = \gamma_1^2 s_t + \frac{1}{2 + (\gamma_1 - \gamma_2)^2 s_t} [1 + \gamma_1 (\gamma_1 - \gamma_2) s_t]^2 \]  \hspace{1cm} (21)

Because of the generalized stationary process \( (\phi_t, \zeta_t), \ t = 0, \pm 1, \pm 2, \cdots \), and there is and
\[ E \phi_t = E \zeta_t = 0 \]  \hspace{1cm} (22)
Covariance \( C_{11} = E \phi_t^2, C_{12} = E \phi_t \zeta_t, C_{22} = E \zeta_t^2 \), and satisfy equations:
\[ C_{11} = \gamma_1^2 c_{11} + 1, \]
\[ C_{12} = \gamma_1 (\gamma_1 - \gamma_2) c_{11} + \gamma_1 \gamma_2 c_{12} + 1, \]
\[ C_{22} = (\gamma_1 - \gamma_2)^2 c_{11} + \gamma_1^2 c_{22} + 2 \gamma_2 (\gamma_1 - \gamma_2) c_{12} + 2 \]

So
\[ C_{11} = \frac{1}{1 - \gamma_1^2}, \quad C_{12} = \frac{1}{1 - \gamma_1^2}, \quad C_{22} = \frac{2 - \gamma_1^2 - \gamma_2^2}{(1 - \gamma_1^2)(1 - \gamma_2^2)} \]

You can find the initial conditions if we notice (24), (25)
\[ \mu_0 = \frac{c_{12}}{c_{22}} \zeta_0 = \frac{1 - \gamma_2^2}{2 - \gamma_1^2 - \gamma_2^2} \zeta_0, \]
\[ s_0 = \frac{c_{11} - c_{12}^2}{c_{22}} = \frac{1}{1 - \gamma_1^2} - \frac{1 - \gamma_2^2}{(1 - \gamma_1^2)(2 - \gamma_1^2 - \gamma_2^2)} = \frac{1}{1 - \gamma_1^2 - \gamma_2^2} \]

So, the useful signal \( \phi_0 \), best linear estimation \( \mu_t \), and MSE \( s_t \) of \( \zeta_0, \cdots, \zeta_t \), within the meaning of mean square can be set according to the equations (20), (21), while the equation has a foundation for the initial conditions
\[ \mu_0 = \frac{1 - \gamma_2^2}{2 - \gamma_1^2 - \gamma_2^2} \zeta_0, \quad s_0 = \frac{1}{2 - \gamma_1^2 - \gamma_2^2} \]

to solve.

5. **Future prospects**
In recent years, big data analysis has become one of the most challenging frontier emerging technologies in current and future research. The combination of big data and intelligent computing was used to solve the big data service and application problems in many fields nowadays. This paper expanded the study of information flow in the ordinary information space to the study of all-directional, multi-angle random dynamic information flow in the generalized information measuring space, which bore more value and information. The paper discussed the recursive filtering algorithm of the best filtration and estimation of a class of measurable and stationary process in multi-dimensional and generalized part, in this generalized process, we try to find and excavate a series of valuable information, and give the best
estimation and the best recursive filtering equation of the random signal in this kind of generalized process, which provides a reliable theoretical basis and effective mathematical method for further research on the optimal control of this kind of process and improving the efficiency of this kind of information transmission system.

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