POLE LIMITATION AND OUTPUT FEEDBACK METHODS OF POLE PLACEMENT

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ABSTRACT

In this paper, a method for setting constraints on closed-loop system poles in single-input systems is proposed using constant feedback from an output vector that is small compared to the state vector. These constraints are linear equations with respect to the coefficients of the characteristic feedback polynomial and are derived from the matrices describing the system in state-space form. The characteristics of the Burke contour poles are then expressed as linear equations in the characteristic polynomial coefficients, and these are solved with the constraint equation to obtain the output feedback vector required to locate the poles.

Keywords: *multidimensional system, modal control, pole placement, synthesis, feedback, closed circuit.*

1. INTRODUCTION

One of the most widely used synthesis methods based on the representation of systems in the state space is the modal control method. Modal control issue, using linear feedback, linear closed systems are used extensively in theory and fully studied. [1-5]. It is known that [1, 6-8], when the input of a control object is more than one, the solutions to the modal management issue are endless, in the matrix of reverse communications will be multi-variant. When it comes to modal management, it is assumed that the private numbers of a solid system are given, and their input is used to change the matrixes of private vectors of solid systems at a certain interval from the freedom that is generated in selecting elements of the reverse communication matrix of many systems.

In recent years, a number of studies have been conducted to develop reverse contact fixers for the placement of poles. Many scientific research studies have feedback and limitations to measure the desired state of the system. However, in most applications, the entire state of the system is not accessible and measurements are limited by the lower number of results available. One common approach to designing a management system is the adoption of additional tools such as the Luenberger status reconstructor for the evaluation of inability situations and then using this assessment to implement reverse-related complete management law on status. Another approach is to use a dynamic feedback compensator to place poles using existing output signals [1, 2, 9]. While it is possible to show that both approaches work at all times in principle, they may not give income from an engineering or economic point of view. Moreover, it is possible to solve the management problem by adding a status recovery device or a dynamic compensator to the system, if the design requirements are much simpler to use existing output signals with appropriate feedback intensity coefficients, using this method leads to several complications.

However, it is often recommended to use a small number of feedback loops for the simplicity of the control structure, even if it is possible to determine all the states of the system. The response of the system is often determined or approximated by several dominant poles, which can only be modified in some cases by means of feedback. Usually, the system includes actuators that operate fast relative to the device, and therefore the poles they input are located at a sufficient distance in the complex plane, their exact location is relatively unimportant, and the location of the feedback around the actuator is unreasonable.

This paper presents a new method for designing controllers with constant output and feedback for pole placement in a complex plane. First, this method exposes limitations to the closed-loop poles that can be achieved when using constant-output feedback. It is known that the coefficients of the characteristic polynomial can be set arbitrarily and without any restrictions when using the complete inverse relationship by state. Coefficients of the characteristic polynomial when using feedback with a constant output $n-l$ it is shown that the system of linear coupling equations must be satisfied. Achieving constraints on feedback poles is an important feature of this method [8-10].

Second, these constraints are used to develop two methods for calculating the constant output feedback required for pole placement. In addition, the results obtained by Davison and Jameson are used to determine the number of poles to be placed.

The simplicity and linearity of this method makes it possible to study the possibility of designing feedback on a constant output before resorting to a more complex structure of dynamic control using a state reconstructor or a dynamic compensator.

2. LIMITATIONS ON THE POLES OF A SINGLE-INPUT SYSTEM

Consider a controllable and observable system with a single input

$$\dot{x} = Ax + bu$$
$$y = Cx$$

The transfer function of this system will look like this

$$Y(s) = \frac{w(s)}{F(s)}U(s)$$

where

$$\frac{w(s)}{F(s)} = \frac{C adj(sI-A)b}{|sI-A|} = \frac{1}{s^n + d_n s^{n-1} + \ldots + d_1}\begin{bmatrix} m_{11} + & \ldots & m_{1n}s^{n-1} \\ \vdots & & \vdots \\ m_{l1} + & \ldots & m_{ln}s^{n-1} \end{bmatrix}$$

$u = v - ky$ – output feedback control law, here v and k – incoming size and l -output feedback vector. Then the inverse characteristic polynomial takes the form of an exponent

$$H(s) = |sI - A + bkC| = s^n + a_n s^{n-1} + \ldots + a_1$$

It is known that $H(s)$ and k directly related to each other

$$H(s) = F(s) + kw(s)$$

$$\sum_{i=1}^{l} k_i w_i(s) = H(s) - F(s) \qquad (1)$$

In equation 1 $H(s), F(s)$ and $w_1(s),...,w_l(s)$ instead of s casting polynomials and on both sides s By equating the coefficients of the same levels of

$$M^T k^T = a - d \qquad (2)$$

where $M -$ full rank $w(s)$ of coefficients $l \times n$ dimensional matrix. a and d and respectively $H(s)$ and $F(s)$ of coefficients n column vectors. Equation 2 l unknown n redefined from Eq $k_1,...,k_l$ is a system. If any l the solution of the equation remains $n-l$ satisfies Eqs., this Eq k will have a solution for

$$Let g(s) = adj(sI - A)b = \begin{bmatrix} l_{11} + & \dots & l_{1n}s^{n-1} \\ \vdots & & \vdots \\ l_{n1} & \dots & l_{nn}s^{n-1} \end{bmatrix}$$

let the transfer function vector of the input state counter be

$$X(s) = \frac{g(s)}{F(s)} U(s).$$

in that case $w(s) = Cg(s)$ and for that reason $M = CL$, here $L - g(s)$ of $\dagger$ of coefficients $n \times n$ dimensional nonsingular matrix.

In equation 2 M the CL we get the following equation by substituting

$$L^T C^T k^T = a - d$$

and $(L^T)^{-1}$ initial multiplication gives the following

$$E k^T = I (L^T)^{-1} (a - d) \qquad (3)$$

here $E = C^T - n \times l$ size matrix, l full rank, $I - n \times n$ dimensional unit matrix. E of the matrix l of linearly independent series $l \times l$ sized E_u matrix formation and I matrix from the same set of rows $l \times n$ in size I_u matrices 3 - the equation can be divided into two equations

$$E_u k^T = I_u (L^T)^{-1} (a - d) \qquad (4)$$

and

$$E_l k^T = I_l (L^T)^{-1} (a - d) \qquad (5)$$

here E_l and I_l in line E and I formed from the remaining rows of $(n-l)\times l$ and $(n-l)\times n$ are matrices. From equation 4 a according to k^T Solving and inserting the obtained solution into Equation 5 gives the following condition for Equation 3:

$$\alpha a = \beta \quad (6)$$

$$\alpha = \{I_l - E_l E_u^{-1} I_u\}\left(L^T\right)^{-1} = S\left(L^T\right)^{-1} \quad (7)$$

here $(n-l)\times n$ is a constant matrix, $\beta = \alpha d$ – $(n-l)$ column constant vector. In equation 7 S – C depends on $(n-l)\times n$ is a dimensional matrix, $S = I_l - C_l^T\left(C_u^T\right)^{-1} I_u$ is calculated from and L only A and b depends on $n\times n$ dimensional matrix.

Equation 6 belongs to the class of closed character polynomials $a_1,...,a_n$ to the coefficients $n-l$ imposes linear constraints

$$H(s) = |sI - A + bkC| = s^n + a_n s^{n-1} + ... + a_1$$

k-output feedback vector. Constraint matrix a full rank $n-l$ has, i.e a which must satisfy the matrix $n-l$ linearly independent.

If the condition in Equation 6 is satisfied, the redefined equation for feedback (Equation 2) is true, and the output feedback vector k From equation 5, it is calculated as follows

$$k^T = R\left(L^T\right)^{-1}(a-d) \quad (8)$$

where

$$R = E_u^{-1} I_u = \left(C_u^T\right)^{-1} I_u \quad (9)$$

3. CONCLUSION

This paper investigates the problem of pole placement in single-input multidimensional systems using constant-output feedback. It is shown that the coefficients of the characteristic polynomials of the Burke circuit obtained with the output feedback must satisfy the linear constraint equation. This constraint equation performs significantly better than other methods of solving the problem.

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