A Method Football Team Model Optimization and Application of the Optimization Control

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Abstract

The development of the AI, IoT, and Big Data have to find an optimization method to reduce the number of parameters in the calculation at any time. We introduce a Football Team Optimization (FTO) method, which is a new method to do optimization problem while control with many parameters system. The application and analysis to compare any method as PSO, traditional PID, which takes out the difference of this algorithm.

We have to meet many applications in the practice to control with a selection of the parameters for one target. In the MIMO systems, as swarm optimization of robot team, choice sensors system in the machines, control planes go up and go down to runway and etc…we have one target for control variables. We call that is a Football Team Model, which is advanced control by self-organized.

There is a system MIMO as figure 5. In that, $\mathbf{x} = [x_1, x_2, \dots, x_n]'$ is a state vector with assume continuous signal and exists high order of derivations, the $\mathbf{x}$ includes input signals $\mathbf{y_0}$, which is a subset of $\mathbf{x}$, $\mathbf{y} = [y_1, y_2, \dots, y_m]'$ is an output vector, $\mathbf{d} = [d_1, d_2, \dots, d_r]'$ is a disturbance vector.

$$\mathbf{x} = \left[x_1, x_2, ..., x_n\right]'; \mathbf{x}^{(1)} = \left[\dot{x}_1, \dot{x}_2, ..., \dot{x}_n\right]; ...; \mathbf{x}^{(l)} = \left[x_1^{(l)}, x_2^{(l)}, ..., x_n^{(l)}\right]$$

We define "distance of control" is a state variable x. That is a difference of set parameter value and output value. Because output signal depends on some input signals (MISO), so we can see that's crossing of the input signals with output signals as figure 6 to calibrate parameters of controller [8],[9].

In figure 6, the block **f**(**e**) decides **e**vector and choices parameter area for calibration. After reduces area of searching, **f**(**e**) does any parameter to directly calibrate.

We go back to our football team as figure 1. A system controls one target at a time with the choice main parameter. Start at $\mathbf{x} \in R^{nx1}$, we choose the main parameter as follow with absolute values:

$$\tilde{x}_k = Min\left(x_1, x_2, ..., x_n\right) \quad \dot{\tilde{x}}_i = Max\left(\dot{x}_1, \dot{x}_2, ..., \dot{x}_n\right) \quad \ddot{\tilde{x}}_j = Max\left(\ddot{x}_1, \ddot{x}_2, ..., \ddot{x}_n\right) \quad \dots$$

We could choice higher order so it isn't well because have to difficultly calculate. After defining the main parameter, we have tree variables with sequence *k, i, j*. In general, $k \neq i \neq j$, so we continue to filter for one time to decide tree couples of variables $\left(\dot{x}_k, \ddot{x}_k\right), \left(x_i, \ddot{x}_i\right), \left(\dot{x}_j, x_j\right)$. If we choose a higher order then we will have set as follow:

$$\left\{\tilde{x}_k = Min\left(\mathbf{x}\right) with\, k \in 1..n ... with\, j \in 1..n ... \tilde{x}_q^{(p)} = Max\left(\mathbf{x}^{(p)}\right) with\, q \in 1..n;\right.$$

And set filter:

$$\left\{\left(\dot{x}_k, \ddot{x}_k, ..., x_k^{(p)}\right); \left(x_i, \ddot{x}_i, ..., x_i^{(p)}\right); \left(x_j, \dot{x}_j, ..., x_j^{(p)}\right) ...; \left(x_q, \dot{x}_q, ..., x_q^{(p-1)}\right)\right.$$

We define a set of the time variable:

$$t_k = \frac{x_k}{\dot{x}_k}, t_k^{(1)} = \frac{\dot{x}_k}{\ddot{x}_k}, ..., t_k^{(p)} = \frac{x_k^{(p-1)}}{x_k^{(p)}} \quad \dots \quad t_q = \frac{x_q}{\dot{x}_q}, t_q^{(1)} = \frac{\dot{x}_q}{\ddot{x}_q}, ..., t_q^{(p)} = \frac{x_q^{(p-1)}}{x_q^{(p)}}$$

We choice x_l with $t_l^{(1)}$. If we have any time variables as same then we continue select to the end of the set variable. After we calculate:

$$t_l = Min\left[\left(\prod_{d=0}^{p-1} t_k^{(d)}\right), \left(\prod_{d=0}^{p-1} t_i^{(d)}\right), ..., \left(\prod_{d=0}^{p-1} t_q^{(d)}\right)\right]$$

And the main parameter is an x_l. So we have to choose the correct parameter to do priority control.

From that, we have a theory:

Theory: If there is a MIMO as (2), we can choice control variable with the law from (6) to (14) to ensure the control time is a minimum.

Simulation

We start action with estimation of PID parameters [10],[11]. Although robot manipulator is a nonlinear system, so we could use PID controller to control with strain domain. After design controller and do it, we receive an error of the trajectories of joint 1st is 15% and joint 2nd is 10% (average value). This is a big error in practice if use big trajectory more.

Reference

[1]. Natika W. Newton, *Understanding and Self-Organization*, Front Syst Neurosci. 2017, Mar 2. doi: 10.3389