Research Article

Modeling and Simulation Based on the Hybrid System of Leasing Equipment Optimal Allocation

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Modeling of the hybrid system of leasing equipment optimal allocation and its optimal control methods are put forward based on the hybrid characteristics of succession and dispersion. After studying equipment unit's hybrid automata model (the hybrid and basic structure), the hybrid system facing manufacture demand can be considered as the synthesis of some hybrid and basic structures, which efficiently avoid combination explosion of models due to the increase of systematic scale. On this basis, we study the hybrid and optimal control methods that meet the demand for some equipment and achieve the usage rate maximization. Following that, calculating methods of performance optimization and simulation are put forward based on the first- and second-order subsection linear model. At last, we also have made the numerical simulating calculation on the equipment's optimal matching of some leasing company.

1. Introduction

In 1986, the concept of hybrid system first was raised in American International Conference and received rapidly the scholars' attention at home and abroad. It gradually is applied to the studies of computer technology, control theory, engineering management, schedule optimization, and so on and combines nonlinear discrete system with the complex system of continuous incidents, which has great guiding significance on the problems about engineering technology, such as scheduling allocation and process control.

The application of the hybrid system in equipment schedule has made research progress. Some literatures analyze and state the theory of hybrid system in detail [1], and also some literatures discuss modeling analytical methods of hybrid system that gathers manufacturing system task scheduling (dispersion) and behavior planning (succession) [2]. The literature [3] studies the fluid models methods similar to the continuous dynamic of discrete system, considering those factors, such as unreliable machine tool and the covering optimal control strategies. The literature [4] states the dynamic

planning methods of the hybrid system's optimal control and comes up with the optimal control of hybrid system based on reached network. The literature [5] takes advantage of the theory of hybrid system to model on electrical system and get estimation of the electrical system and its voltage stability. Then, it raises the theoretical framework of differential algebra hybrid system stability including stability and asymptotic stability.

This essay mainly describes the equipment leasing and its dynamics. Meanwhile, it puts forward the simulation methods and uses certainty to deal with the equipment utility and the condition of maintenance.

2. Hybrid Characteristics and Optimal Allocation of Equipment Leasing Process

Figure 1 is the schematic diagram of equipment leasing. The equipment is the main body of implementation of circulation, which can meet a variety of technical requirements. The idle area before each device is for improving the problems caused by different devices in circulation time of the logistics balance

FIGURE 1: The schematic diagram of equipment leasing.

problems and maintenance issues to avoid congestion, the maintenance phenomenon of the used process. Equipment scheduling system is the guaranteed system of uninterrupted scheduling; it prevents the equipment from causing interruption to the customer, and the idle equipment will return to repair free zone.

The equipment leasing dynamic process clearly showed continuous and discrete hybrid nature of coexistence. The equipment in use area or rent-seeking area is a continuous process, “the devices in use area” and “equipment in rent-seeking area” driven in the scheduling process, at the same time the system will make the leap scheduling of equipment state when discrete event happens such as obstruction logistics and equipment failure.

Optimization scheduling configuration equipment leasing refers to the choice of continuous or discrete variables appropriately, makes a performance index of the system to achieve optimally, and maximizes the utilization and rational allocation of existing resources, which is an important way of equipment leasing enterprises to reduce production costs and improve production efficiency. To consider the influence of many factors, to which an optimization strategy is determined according to the specific characteristics of different production environment, under normal circumstances, the whole construction process as a whole is optimized, through the rational allocation of construction equipment in the process of production and construction of rhythm, so that the construction speed when satisfying the conditions reached the fastest. This strategy is not adapted to many varieties, small batch production environment. In order to improve the overall yield, it is also needed to consider different products for transformation and adjustment. In addition, the idle area capacity size, position number, also directly affects the production efficiency, so, in the system idle area capacity sum of certain conditions, optimum configuration of each spare area of capacity construction process also is an effective measure to improve the system performance index.

3. Hybrid System Modeling and Optimization of Equipment Leasing

3.1. Modeling Methods of Hybrid System Equipment Leasing. Device scheduling unit s_i contains user area and rent-seeking area; all units have the same dynamic migration patterns. So by analyzing unit s_i the whole system can be understood. “Empty” rent-seeking region of B_i , “Full,” and “Not Empty

Not Full” 3 states, respectively, indicates that the number of workpieces in rent-seeking district was 0, reaching the rated capacity and between Empty and Full; user M_i also have “Idle,” “Operational” and “Broken” states in 3 states, respectively. The table shows that the user is in standby, working state, and failure state. The user area and rent-seeking area combined to form 9 kinds of states, respectively, “B-E, M-I,” “B-N, M-I,” “B-F, M-I,” “B-E, M-O,” “B-N, M-O,” “B-F, M-O,” “B-E, M-B,” “B-N, M-B,” and “B-F, M-B.”

In order to better study the optimization problem of mixed configuration, make the following assumptions:

- ① The equipment is in a very small time step using a unit in the same discrete state; state transfer does not occur.
- ② The fault that occurred only works in the user area standby state and does not generate fault.
- ③ The use of cycle in the same state of the user equipment is constant. In the hybrid automata model device using the unit of s_i as shown in Figure 2, the state variables in the X_i diagram, X_i and s_i , denote the number of quantities, the workpiece buffer in B_i M_i devices and in a nonoperating state of clock variables. The equipment enters into the work state after standby time a_i . Failure occurs before production of U_i . After production completed w_i enters standby mode. Work starts from the fault status time e_i ($e_i < d_i$) or enters standby mode after time d_i ; otherwise it enters the standby state after d_i . Rent-seeking area state is full or empty or nonnull full and empty. s_i can be of different varieties modeled for hybrid automata model initialization, so hybrid automata in the graph are not given initial state.

Each s_i can be used in similar hybrid automata model (hybrid elementary structure of EHSi) to be indicate; hybrid system for equipment scheduling can be thought of as being plurality generated by public variables and information transmission hybrid elementary structure synthesized. In all of the EHSi parallel operations, public variable refers to the output signal (such as rent-seeking area capacity) of each EHSi and from the outside of the signal (such as initial equipment scheduling speed). This modeling approach to make the pieces of equipment leasing in the scheduling and the corresponding hybrid elementary structure corresponds to one, not as the system size growth presents the combination

FIGURE 2: The hybrid automata model device using the unit of s_i .

explosion phenomenon and effectively avoids the total size of equipment to the complexity caused by the growth model.

3.2. Optimal Control. A hybrid control system refers to the object or the controller contains both discrete and continuous part, and the discrete part and a continuous part work together to determine the performance of the system. The scheduler or monitoring management are the discrete control form; the continuous part show the discrete system dynamic characteristics. According to the definition of hybrid systems, the current international control modeling of hybrid systems field mainly focuses on two aspects: on the one hand there is the discrete event dynamic system model based on the hybrid system, which will be considered as discrete event dynamic system model, to realize the modeling according to the property of discrete events of partition of the continuous state space, and then continuous process acts as a discrete event system which is embedded into the low, for example, automata model, the hierarchical structure model, based on

the Petri network based on the previously mentioned (HPN) model; on the other hand, there is a continuous variable dynamic system model based on the entire system, and is regarded as the switching conditions and disturbance to deal with, for example, the switched system model mixed logic dynamic model and event flow formula model (EFF).

The hybrid system is modeled as a set with a certain constraint linear dynamic equation, using piecewise linear approximation of nonlinear process to the whole, linearized at the equilibrium point of each segment space; the discrete parts in the model are reflected from a linear process of transition to the switching condition under a linear process. The state space expression of the model is as follows:

$$x(t+1) = \begin{cases} A_1 x(t) + B_1 u(t) & \text{if } \delta_1(t) = 1 \\ \vdots \\ A_n x(t) + B_n u(t) & \text{if } \delta_n(t) = 1. \end{cases} \quad (1)$$

FIGURE 3: A fuzzy multimodel control scheme of hybrid system.

FIGURE 4: The response of the first-order piecewise linear model with trace variable to input.

Design of linear process conditions for switching system and fuzzy multiobjective model controller is carried out to achieve optimal control for hybrid systems. Hybrid system multiple model control structure is as shown in Figure 3.

Design of fuzzy multimodel controller can be divided into two steps: firstly, design of controller applied to a single piecewise linear process, design standards, is to ensure that a single piecewise linear process to achieve stability has good dynamic quality; secondly, design of the fuzzy supervisory controller, design standards, is to ensure the stability hybrid process, from the whole set value performance of tracking performance and antidisturbance of local controller switching.

4. Research on Simulation

In order to verify the effect of control method, the first-order linear typical hybrid system characteristics and the second-order piecewise linear model are established. The model set is given, without linearization and controller sets and switching principle design, where in the switching principle using fuzzy supervisory control is thought.

A hybrid system of a typical first-order piecewise linear model:

$$x(k+1) = \begin{cases} 0.8x(k) + u(k) & x(k) \geq 0 \\ -0.8x(k) + u(k) & x(k) < 0, \end{cases} \quad (2)$$

$$y(k) = x(k).$$

Two-order linear model:

$$\begin{aligned} x(k+1) &= 0.8 \begin{bmatrix} \cos a(t) & -\sin a(t) \\ \sin a(t) & \cos a(t) \end{bmatrix} x(t) \\ &\quad + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t), \\ y(t) &= [1 \ 0] x(t), \\ a(t) &= \begin{cases} \frac{\pi}{3} & \text{if } [1 \ 0] x(t) \geq 0 \\ -\frac{\pi}{3} & \text{if } [1 \ 0] x(t) < 0. \end{cases} \end{aligned} \quad (3)$$

In view of the above model, the piecewise linear process is relatively simple, so the local controller fuzzy multimodel control adopts PID controller which can achieve better control effect, respectively, to each piecewise linear process design different PID controller. According to the switching conditions of the system, error and error change rate are supervisor-designed weights of each controller output. When the system is composed of a state switch to another state, the controller output weights are also correspondingly adjusted; once the switch is completed, the weight does no longer change, unless the state of the system jumps again. The first-order piecewise linear model for hybrid control system of variable input tracking response is shown in Figure 4; two-order piecewise linear model of hybrid control system of variable input tracking response is as shown in Figure 5.

FIGURE 5: The response of the second-order piecewise linear model with trace variable to input.

5. Conclusion

Hybrid system modeling and optimization control methods of optimal allocation of lease equipment based on scheduling are proposed in this essay. The simulation results verify the feasibility of the research method and the effectiveness. And mathematical model of the optimal control is given to meet the required rate to maximize the use of machinery and equipment under full load within a certain period of time with production scheduling simulation of the limited storage capacity. Application study of hybrid system theory is applied in the intelligent transportation systems, air traffic control, robot system, chemical system, manufacturing system of power system, and other fields and, in addition to the above areas, in large scale complex industrial system, and also has the broad application of Internet, network, and other fields of biological molecules prospect.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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