Research on Simulation and Real-Time Evaluation Method of IoT-Oriented Complex System

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Abstract. Mathematics and the traditional method faced some limits on the complex system, this paper setup a methodology of simulation and real-time evaluation on the IoT-oriented complex system, introduced in detail about gaining the information of simulation object, establishing the standard mode library, evaluating real-time status and determining the evaluation results.

Keywords: simulation, real-time evaluation, Internet of Things(IOT), complex system.

1 Introduction

With the continuous development of Internet of Things (IOT), the complexity of modern industrial control systems is becoming more and more serious, and the relevant control systems were also updated gradually from the traditional centralized-control system to the distributed-control system. Compared to the traditional centralized-control system, the distributed-control system of IoT is more flexible, more convenient, more reliable and more efficient. However, on the other hand, such update also brought new problems and challenges such as: the problems caused by saturated or overload communication network, data security issues caused by data sharing, and system performance issues. In addition, the distributed control system of IoT demonstrates high requirements in reliability, real-time, extension and coordination. Finally, the diversity of terminal equipment and the complexity of the control equipment can also cause the system error accumulation.

Mathematics and the traditional method faced some limits on the complex system, especially when the complex system features itself as having multiple dimensions, multiple objectives, and involves many factors and non linear relationship. In such scenario, computer simulation was widely used and became the most effective way for the complex systems. This paper is trying to setup a methodology of real-time evaluation on the complex system from the perspective of simulation platform.
2 Related Works

The research about complex system real-time evaluation is less, the related works introduced from two aspects: 1) simulation; 2) measure method of vector similarity.

2.1 Simulation

The concept of distributed interactive simulation was first proposed by the American Defense’s SIMNET project in the 1980s. Distributed interactive simulation integrates many new contemporary technologies based on computer network technology. It creates the possibility of complex system simulation.

The method of simulation technology for complex system was usually based on AGENT. Mr. R.Boero[1] set up Agent-Based Modeling and Simulation (ABMS), including ABMS basic theory, ABMS formation & method verification, ABMS model testing, and etc. Based on ABMS, Mr. R.Leombruni[2][3] further developed it to the application on economy and social issue. Kennedy and Eberhar set up the particle swarm optimizing algorithmic[4]. G.Wagner, S.C.Bankes, L.Henrickson[5][6][7][8] and others also advanced the simulation theory and method based on agent.


In china, the research about complex system simulation focus on modeling method and applications, and most of them were for specific projects. Although certain modeling theory and method were set up, the majority of such research was merely the summary and explanation to the foreign papers. The real innovation is less.

2.2 Measure Method of Vector Similarity

Measure method of vector similarity was generally divided into two categories: distance measure method and similarity function method. Distance measure methods include Euclidean Distance, Manhattan Distance, Minkowski Distance, Mahalanobbis Distance[14], and etc. Vector distance should meet the followings[15][16]:

\[ D(X, Y) \geq 0 \]  \quad \text{When and only if } X = Y, \text{ the equality holds}  \\
\[ D(X, Y) = D(Y, X) \]  \\
\[ D(X, Y) \leq D(X, Z) + D(Z, Y) \]

Calculation method of Minkowski Distance is the general calculated Distance form, expressed as:

\[ D(X, Y) = \left( \sum_{i=1}^{n} |x_i - y_i|^m \right)^{1/m}. \]