Research on PHM Architecture of Cloud Test

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Abstract. In view of the low utilization rate of the test data in the current cloud test system, the advantages of cloud test in computing and storage are not fully utilized, and a cloud-based fault prediction and health management (PHM) system based on test data is proposed. Firstly, it analyzes the shortcomings of the existing cloud computing PHM architecture, and proposes a cloud test PHM architecture based on test data. This method can effectively improve the utilization of cloud test data and provide theoretical support for the development of cloud test systems.

Introduction

With the popularity of cloud computing technology, cloud test has become a new research hotspot in the field of testing in recent years[1]. Cloud test refers to automatic test technology based on cloud computing platform, which shows low hardware cost, strong processing power, large storage space and using convenience and other advantages[2]. Fault prediction and health management (PHM) refers to equipment management solutions that combine test data, expert knowledge, maintenance support information, and artificial intelligence to achieve monitoring, interpretation, prediction, and management of the operational status of the device[3], which is under test. How to combine the new technologies in these two test areas will be an important research direction, so this article has carried out related research on this aspect.

The cloud test solves the information communication problem of the traditional test system, stores a large amount of test data, how to obtain the performance status of the equipment from these test data, and conducts health management and life estimation, thereby establishing a cloud test PHM system, which will be a important research direction of cloud test[4]. Scholars all over the world have also done a lot of research on this aspect. The article [5] designs the PHM system architecture for command and control equipment for cloud services, but only gives a theoretical framework and does not involve specific implementation. The article [6] proposes a cloud computing aircraft PHM system, but only deals with virtual resource allocation, and does not involve PHM core content. In view of the low utilization rate of existing cloud test data and the imperfect function of cloud test PHM system, this paper proposes a SOA-based cloud test PHM architecture with test data as the core.

Cloud Computing PHM Architecture

Improvements and Shortcomings

The proposed cloud computing PHM system, compared with the traditional PHM system, mainly improves the resource virtualization and networked services, and fails to effectively utilize the powerful data storage and processing performance of the cloud computing platform. Therefore, it is necessary to establish a cloud test PHM system with test data as the core, with data management and data mining as the core functions, give full play to the performance advantages of the cloud test system, and improve the comprehensive support capability of the cloud test system.
Cloud Computing PHM Architecture

The traditional PHM system can be divided into six layers according to their functions: data processing layer, condition monitoring layer, fault diagnosis layer, fault prediction layer, decision support layer and expression layer\(^7\). The cloud computing technology has the following outstanding features: (1) Replacing the test subject in the traditional automatic test system, such as a microprocessor or a computer, with a cloud computing platform; (2) Virtualizing test resources into a shared resource pool as services, which are provided to all users; (3) Provide networked services, solve the problem of information silos in the traditional test systems, and provide the possibility of separating test entities from data processing. Based on the above characteristics of the cloud test system, the existing cloud computing PHM system can be divided into a physical resource layer, a virtual resource layer, a service layer, and an expression layer, as shown in Fig. 1.

![Figure 1. Cloud computing PHM architecture.](image)

SOA-Based Cloud Test PHM Architecture

Test data is the core of the test system. The intelligent management and reuse of test data has become a research hotspot in the field of automatic test\(^8\). The diagnosis, classification and prediction of faults depend on the efficient processing of test data. Traditional test systems store and process test data in isolation, failing to achieve sharing of test data between different test systems and efficient use of massive test data. In the cloud test system, the cloud computing platform relies on networked services to store a large amount of test data. Therefore, it is necessary to establish a PHM architecture with test data as the core, according to the characteristics of cloud test.

This paper proposes a cloud test PHM system based on Service Oriented Architecture (SOA)\(^9\). The architecture links these services by dividing the services which can provide different function, and defining corresponding data interfaces. It is shown in Fig 2.

1) Virtual resource layer: In the cloud test system, the test resource and the data processor are separated by the network. The virtual resource pool built by the cloud test system can access standardized test instruments from different regions, different users and different manufacturers, relying on virtualization technology. It is managed and used in a unified manner.

2) Data management layer: The data structure of test data is diverse, the sampling method is diverse, and there are many redundant information, which brings many difficulties to the management of test data. The data management layer includes the capability of standardization, structuring, screening, integration, classification, and storage for the test data.
(3) Data mining layer: Fault diagnosis and prediction in the traditional PHM system depend on the initial health model of the single curing of the device which is under test, and it is impossible to intelligently process the dynamically changing test data. From the perspective of data mining, fault diagnosis is the spatiotemporal anomaly detection, co-occurrence pattern mining and association model mining of test data. According to the demand, the useful information in the test data is mined, and the polymorphic modeling and self-renewal of the health state are realized, and the targeted use of the massive test data is realized, and the functional service to the user is realized.

(4) User interface layer: Provide different levels of services for different user needs. It can be provided according to user requirements: (1) Software as a Service (SaaS); (2) Platform as a Service (PaaS); (3) Infrastructure as a Service (IaaS) and other levels of services. Through the layered service model, customized functions are provided for different users, which improves the utilization of test data and meets the requirements of different users.

Information Flow

The information flow of the whole system can be described as: (1) Connecting the test resources and the measured object through the test connection, obtaining the response through the input stimulus, and obtaining the test signal; (2) Through the virtualization technology, the distributed entity test resources are abstracted into virtual test resources, and the test resources and test signals are described by standard of ATML; (3) The test data obtained by the virtual resource pool, which is processed to perform of multi-dimensional test data management; (4) For different test requirements, select different data mining methods; (5) Call test data mining results according to different service interface requirements; (6) Provide services with different privilege levels according to user requirements, and access corresponding service interfaces.

By integrating the different levels of services provided by the virtual resource layer, data management layer, data mining layer and user interface layer, a cloud test PHM architecture based on test data is formed. Through simulation, we found that this cloud test PHM architecture based on SOA framework can effectively improve the storage and management ability of test data, and lay a foundation for more efficient and reliable cloud test failure prediction and health management. In addition, due to the openness of the architecture, which support for the continuous extension and
expansion in the later stage. In summary, the cloud test PHM architecture based on the SOA framework proposed in this paper has a good application prospect.

Summary
This paper proposes a cloud test PHM architecture based on SOA framework with test data as the core, and the method is adapted to the characteristics of cloud test system’s mass storage and processing ability for the test data. This architecture has been used as a verification technique for a cloud test system. The cloud test PHM architecture proposed in this paper expands the new method for improving equipment test efficiency and security level, and has important theoretical and practical value.

References
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