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The Current Status and Future Perspectives of Virtual Maintenance

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Abstract

Virtual maintenance, which is widely used in aerospace, automobile, military equipment, etc., has been given abroad attention among equipment life-cycle including concept definition, system design, component production, daily operation, troubleshooting, and so on. Virtual maintenance has been given many different definitions and lot of technologies for implementation, but there is no clear systematic conclusion on the both. Based on the review of the current achievements, the elements of virtual maintenance are extracted, the technologies are systematically explored, and the applications are developed. Meanwhile, the future perspectives of virtual maintenance are discussed associated with virtual reality and augmented reality, multi-person collaboration, remote assistance, as well as artificial intelligence.

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1. Introduction

With the rapid development of modern high-technologies and its application in the equipment, the structure and function of the equipment is more complex and diverse, not only increasing the dependence on maintenance, but also bringing the new challenges to the maintenance. The traditional method of using the physical equipment maintenance is not able to meet the current maintenance needs. To implement effective maintenance, modern science and technology are good choices. With the development of virtual reality, the virtual maintenance technology combined with computer technology provides a new method to solve above problems.

This paper introduces the development of virtual maintenance from the evolution of virtual maintenance concept. We summarize the current situation and existing problems of virtual maintenance, and prospects the future

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developing trend of virtual maintenance based on the research on key technologies involved in virtual maintenance system.

2. Evolution of Virtual Maintenance Concept and Elements Analysis

2.1. Definition of virtual maintenance

The concept of virtual maintenance has been proposed so far, and the study of virtual maintenance has developed from the aerospace field to various industries. However, the definition of virtual maintenance is not clear, and international standards are not uniform.

The main content of maintenance is disassembly, and virtual maintenance is defined as the evaluation of maintainability by virtual assembly environment in the literature 1. This circumscription that defines virtual maintenance as virtual assembly elegantly showing the main activity that maintenance is involved, while defining maintenance as disassembly narrows the range of the maintenance [1].

With the development of computer simulation technology, the form of virtual maintenance has changed. The definition of Virtual Maintenance in the literature 2 is: "Maintenance is a computer simulation technology that virtual trainees can operate the model machine in the virtual environment." This definition delineates virtual maintenance as a computer simulation technique that focuses on simulating a virtual prototype， which is not involved in the operation during the implementation process and maintenance engineer [2].

The definition given in literature 3 is: "Virtual maintenance is based on the computer technology and virtual reality, the virtual scene including product digital prototyping and maintenance engineer 3D human model is computer-generated, and the integrated application technology of the entire maintenance process simulation is completed by driving the model of human body." This definition not only shows the object and engineer of virtual maintenance, but also represents the maintenance process and tools. But it does not give the purpose of virtual maintenance [3].

Combining with the definition of literature 3, the definition in literature 4 is: "Virtual maintenance is based on computer technology and virtual reality technology. The virtual scene including product digital prototyping and 3D human model of maintenance engineer is computer-generated, driving the model of human body and using human-machine interaction technology to complete maintenance process, achieving the purpose of verifying maintenance, simulating maintenance process, maintenance training and maintenance design." The definition comprehensively responding the current virtual maintenance with various objects involved is regarded as a currently accurate definition. With the development of virtual maintenance, its definition will be more complete [4].

2.2. Elements of Virtual Maintenance

It can be drawn from the definition that virtual maintenance contains the following four elements:

Virtual Maintenance Object: a virtual model for maintenance. Virtual objects should have the characteristics of physical maintenance objects, including geometric features and functional characteristics. And virtual objects also can simulate these characteristics.

Virtual Maintenance Engineer: mannequins that operate on repaired objects, including the virtual human model in the form of "Virtual Human Maintenance Virtual Product", and real people in the form of "Real People Maintained Virtual Products".

Virtual Maintenance Tools: a virtual model of the tools used in real-world repairs. It can simulate the external form and function of the tools.

Virtual maintenance process: the entire process during which maintenance engineer uses virtual maintenance tools to repair some objects. The process should be a detailed representation of real maintenance process information.