Development of deep learning AI-based electronic circuit card assembly (PCB) diagnosis technology

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1. Introduction

We have developed a PCB diagnosis technology linked to artificial intelligence technology that can quickly test the soundness of the circuit card assembly (PCB) of the nuclear power plant I&C system and improve test reliability.

Until now, PCB test equipment has been developed by several developers and tested using various test methods. Among these test methods, the bed of nail method, which tests components on the PCB by directly connecting them, the functional test, which tests performance or function through connector pins, and the JTAG test method are mainly applied.

In this study, we designed the system to be able to perform integrated functional tests for each User Defined Pin and developed a system using a personal computer (PC) to control the test equipment instead of reading the test progress screen on the test equipment.

2. Methods and Results

In this technology, when pre-learned inspection requirements for each PCB type are transmitted to the test equipment, the test equipment receives a test request from the PC and sequentially performs tests for each function of the PCB under test. Then the test results are evaluated by comparing them with the data of a healthy PCB learned through deep learning. In addition, the test results are stored cumulatively on the PC so that the degree of aging and deterioration of the PCB card can be continuously tracked in the future.

2.1 Research Contents and Goals

This study purposed to improve productivity and reliability through automated functional testing of circuit card assemblies (PCBs) that perform various functions in electronic devices. Productivity improvement means reducing human testing as much as possible, reducing the number of test equipment to test various PCBs, and automating the diagnosis of PCB by adopting AI technology.

Until now, PCB test equipment has been developed by several developers and tested using various test methods. In this study, we studied how to solve this problem by reducing the number of test equipment and making it possible to automatically test all input and output functions.

2.2 PCB diagnosis Methods

Before developing the diagnosis equipment, we reviewed the several types and test methods of commonly used. There may be a variety of test equipment, but the equipment that has been widely used recently is mainly the Bed of Nail method, which tests components on the PCB by directly connecting them, the Functional test method, which tests performance or function through connector pins. In other systems where equipment is miniaturized and complex, the equipment using JTAG components is mainly used. This study aimed to develop automated test equipment with complex functions by analyzing the pros and cons of these equipment.

Table 1. Types by PCB diagnostic function

Type	Advantages	Disadvantages
Bed of Nail Tester	- Test by part - S/W by component characteristics - Simple S/W structure	- Fixture for each PCB - Complicated mechanism design - Increased test costs
Functional Tester	- Simplification possible by function - Implementation of inspection equipment at low cost - BIT S/W reuse	- Inspection S/W complicated - Part-level testing is not possible
JTAG Testing	- Highly integrated circuit test - Simple test equipment - High reliability	- JTAG parts are expensive - Passive elements cannot be inspected

2.3 PCB Test Equipment Configuration

Test equipment for circuit card assemblies must be designed to perform functional tests for each User

Defined Pin.

Although it is possible to design the test progress screen to be processed in the test equipment, in this study, in order to reuse the BIT program of the main mission equipment, the test equipment was developed separately by applying a laptop that controls the test equipment. Figure 1. is a configuration diagram of the test equipment.

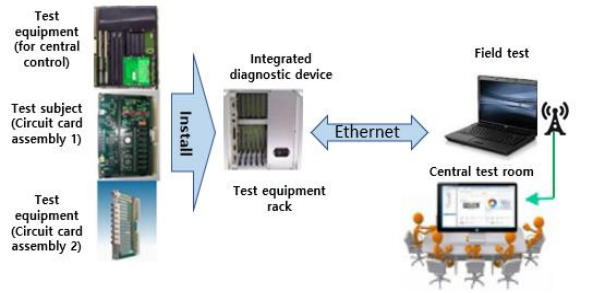

Fig. 1 PCB test equipment configuration

3. Results and Discussions

The development of automated PCB diagnostic equipment to improve productivity enabled simultaneous diagnosis of multiple PCBs by assigning signal specifications to each pin according to the characteristics of the PCB from the initial design.

In addition, the PCB diagnostic equipment receives test requests from laptops and sequentially performs tests for each function of the PCB under test. The test results are delivered to the laptop, and the performance of the circuit card under test can be judged based on AI learned knowledge. The pictures below graphically show the diagnosis process and results.

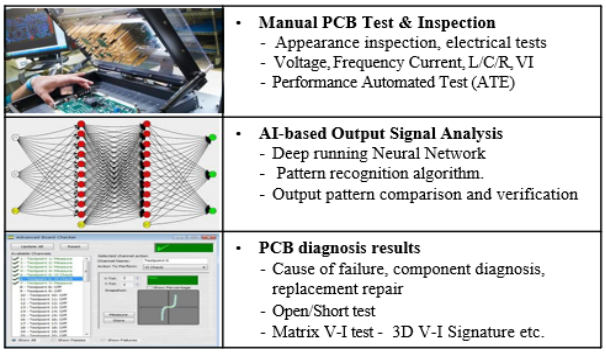

Fig. 2 PCB test model and results

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