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Chapter XVI

Intelligent Remote Monitoring and Maintenance Systems

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Abstract

Internet-based intelligent fault diagnosis and maintenance technologies are keys for enterprises to achieve global leadership in market competition and manufacturing productivity for business in the 21st century. E-products, e-manufacturing, and e-service have been the goals of enterprises: (1) Next generation products must be network-based products — e-products. The vast developments of IT technology-based hardware and software make the controller of Internet-based products cheaper; (2) Common facilities such as Internet and World Wide Web, 3G (GPS, GPRS, and GIS) make e-maintenance or e-service cheaper and easier; (3) "Server-Web-user" methodology makes e-manufacturing possible, convenient, and efficient. To achieve these goals, smart software and NetWare are needed to provide proactive maintenance capabilities such as performance degradation measurement, fault recovery, self-maintenance, and remote diagnostics. This chapter presents methodologies and techniques for the development of an Internet server controller-based intelligent remote monitoring and maintenance system. Discussion involves how to make innovations and de-

velop products and manufacturing systems using Internet-based intelligent technologies and how to ensure product quality, coordinate activities, reduce costs, and change maintenance practice from the breakdown reaction to prevention. A hybrid intelligent approach using hardware and software agents (watchdog agent) is adopted. The server controller is Web-enabled, and its core is an embedded network model. The software agent is implemented through a package of Smart Prognostics Algorithms. The package consists of embedded computational prognostic algorithms developed using neural network based, time-series based, wavelet-based and hybrid joint time-frequency methods, and so forth, and a software toolbox for predicting degradation of devices and systems. The effectiveness of the proposed scheme is verified in a real testbed system.

Introduction

Globalization and fast growth of the Internet technologies and information technologies have added unprecedented challenges to industry. In the past decade, the impact of Web-based e-system technologies has accelerated the development process of products including product design, manufacturing, and business operations. Business automation is forcing companies to shift operations from the traditional "factory integration" philosophy to a "virtual factory" supply chain management philosophy (NRC, 1990). The technological advances to achieve this highly collaborative design and manufacturing environment are based on multimedia type information-based engineering tools and a highly reliable communication system to enable distributed procedures in concurrent engineering design, remote operation of manufacturing processes, and operation of distributed production systems. This transition is dependent upon the advancement of next-generation manufacturing practices on "e-factory and e-automation," which is focused on the use of information to collaboration on a global basis. Quality is no longer an objective; it is a prerequisite for competing in the global marketplace. In addition, the complexity of today's products has greatly attracted consumers' attention to the service cost of the product's life cycle. A new paradigm on robust engineering to focus on e-intelligence for integrated product design, manufacturing, and service is becoming a new benchmark strategy for manufacturing companies to compete in the 21st century (Lee, 1998, 1999, 2000).

Industry and government are constantly under economic pressures to reduce costs while increasing service and productivity. Because of the low labor cost, multinational companies establish many sub-factories in the developing countries and outsource some of their businesses. With the development of globally integrated activities manufacturing equipment becomes more complex and more costly to build and maintain. A leading manufacturing organization supported with global customer service should be flexible enough in management and labor practices, and possess the ability to develop and produce virtually defect-free products quickly in response to opportunities and needs of the changing world market. Because of the rapid growth of the global market, the fast responsive maintenance and service are becoming more and more important for companies to sustain their manufacturing productivity and customer satisfaction to compete globally (Lee, 2003). An intelligent e-maintenance system is a need for next-generation products and manufacturing systems. Future smart manufacturing companies necessitate a set of core intelligences to address