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A web-based intelligent fault diagnosis system for customer service support

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Abstract

In traditional help desk service centres, service engineers provide a world-wide customer support service through the use of long-distance telephone calls. Such a mode of support is found to be inefficient, ineffective and generally results in high costs, long service cycles, and poor quality of service. With the advent of the Internet technology, it is possible to deliver customer service support over the World Wide Web. This paper describes a Web-based intelligent fault diagnosis system, known as WebService, to support customer service over the Web. In the WebService system, a hybrid case-based reasoning (CBR) and artificial neural network (ANN) approach is adopted as the intelligent technique for machine fault diagnosis. Instead of using traditional CBR technique for indexing, retrieval and adaptation, the hybrid CBR–ANN approach integrates ANN with the CBR cycle to extract knowledge from service records of the customer service database and subsequently recall the appropriate service records using this knowledge during the retrieval phase.

Keywords: Web-based help desk; Intelligent fault diagnosis; Hybrid approach; Case-based reasoning; Artificial neural network

1. Introduction

A multinational corporation in Singapore manufactures and supplies insertion and surface mount machines widely used in the electronics industry. Its customer support department services its world-wide customers and provides installation, inspection and maintenance support for its customers. Insertion and surface mount machines are expensive and require efficient maintenance during machine down time. Although most customers have some engineers to handle day-to-day maintenance and small-scale troubleshooting, expert advice is often required for more complex maintenance and repair jobs. Prompt response to request from customers is needed to maintain customer satisfaction. Therefore, the multinational corporation has set up a hotline service centre (or help desk) to answer frequently encountered problems.

The hotline service centre is responsible for receiving reports on faulty machines or inquiries from their customers via telephone calls. When a problem is reported, a service engineer will suggest a series of checkpoints to the customers to implement or check as a means to rectify the reported problem. Such suggestions are based on past experience or extracted through a customer service database that contains previous service records that are identical or similar to the current one.

With these checkpoints, the customer attempts problem solving and subsequently confirms with the service centre if the problem is resolved. If the problem still persists after all the suggested checkpoints are exhausted, the centre will dispatch the service engineers to the customer's premise for an on-site repair. During such trips, the service engineers will carry along with them past records of the customer's machine, related manuals and spare parts that may be required to carry out the repair. Such a process is inconvenient and often involves bringing redundant materials.

At the end of each service cycle, a customer service report is used to record the reported problem and proposed remedies or suggestions taken to rectify the problem. This is for billing purposes, as well as maintaining a corporate knowledge base. The service centre then updates the customer service report in the customer service database.

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This traditional customer support process suffers from a number of disadvantages:

- The process is time-consuming and expensive. More often than not, service engineers are required to travel to a customer's site for an on-site service even for a small problem. As a result, the problem cannot be resolved efficiently and the machine down time can be significant. In addition, as the customers communicate with the help desk centre via telephone calls, they incur long distance telephone charges as most of them are located overseas.
- A certain number of service engineers are maintained in order to provide the service support. It needs to keep on training new service engineers, and at the same time, come up with new incentive scheme to retain experienced service engineers.
- Expert advice to the problem is given either through the experience of the service engineers or the available past service information in the service database. No automatic provision of expert advice is available.

As can be seen from this mode of operation, the identification of machine faults relies heavily on the service support engineers' past experience or the information drawn from the service database. This method has a problem of training and maintaining a pool of expert service engineers. Thus, instead of relying on the knowledge of service engineers, an intelligent fault diagnosis system that captures the expert knowledge of machine diagnosis to assist customers identify machine faults becomes extremely useful. This system should be able to generate suggested remedial actions automatically or through user-interaction based on the observed fault-conditions.

In addition, the advancement of the Internet technology has made it possible to deliver customer service support over the World Wide Web (or Web). Therefore, as a collaborative project between the multinational corporation and the School of Applied Science, Nanyang Technological University, Singapore, a Web-based intelligent fault diagnosis system, known as WebService, has been developed in order to enhance the customer service support over the Web. In this research, a hybrid case-based reasoning (CBR) and artificial neural network (ANN) approach (Lees and Corchado, 1997; Papagni et al., 1997) is adopted as the intelligent technique for fault-diagnosis. The hybrid CBR-ANN approach is operated as follows. Instead of using traditional CBR technique for indexing, retrieval and adaptation, ANN is incorporated into the CBR cycle to extract knowledge from service reports of the customer service database and subsequently recall the appropriate service reports using this knowledge during the retrieval phase.

The rest of the paper is organised as follows. Section 2 discusses the on-line customer service support. Section 3 reviews the intelligent techniques for fault diagnosis. The system architecture of WebService is given in Section 4. Section 5 describes the structure of the customer service database. Section 6 outlines the proposed hybrid CBR–ANN technique for intelligent fault diagnosis. Section 7 gives the performance evaluation of the hybrid approach. Finally, conclusion is given in Section 8.

2. On-line customer service support

The earliest form of on-line customer service support is supported through bulletin board systems (BBSs) as on-line help desk. However, BBSs are basically command-driven systems, they are not user-friendly and require some learning of corresponding commands prior to use. With the advent of Web technology that can provide dynamic, interactive, hypermedia, platform independent, distributed and client/server services, such BBSs have become obsolete. The Web environment has obviously become a leading contender to provide on-line help desk support. Using this environment, customers can access the on-line knowledge database via any Web browsers such as Netscape's Navigator or Microsoft's Internet Explorer. If the problem cannot be resolved through the use of the on-line help desk functions, the customers can fill out a standard help request form to document their problems. This form can then be automatically routed to the experienced service engineers for further response.

Currently, a number of commercial help desk products for customer support, such as WebLink and WebSupport (Muller, 1996), are available. In addition to providing general Web support for accessing its knowledge database of problem solutions, these systems also support automatic problem diagnosis through artificial intelligence technology. The current trend of Web-based customer service support is gaining acceptability and many multinational corporations such as Compaq and NEC have adopted such an approach.

3. Intelligent fault diagnosis

For the past few decades, there have been a proliferation of intelligent systems for fault diagnosis and related applications (Balakrishnan and Honavar, 1998). Traditionally, CBR has been successfully applied to fault diagnosis for customer service support or help desk (House, 1994; Law et al., 1997; Liu and Yan, 1997; Patterson and Hughes, 1997; Shimazu et al., 1994). CBR systems rely on building a large repository of diagnostic cases (or past service reports) in order to circumvent the difficult task of extracting and encoding expert domain knowledge (Riesbeck and Schank, 1989). It is one of the