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論 文 名 「Web-Based Control and Data Processing  
System for Wide Variety of Applications」  
(多方面に適用可能なウェブ上の制御・データ処理シ  
ステム)

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## 論文要旨

World Wide Web (WWW) is one of applications over the Internet, providing the function of browsing web documents published by web servers all over the world. Due to the development of the WWW technologies, the service provided by WWW was changed from the static service to browse the web documents to the dynamic service to offer the workspace for users to process data such as creating the multimedia contents, and authoring the business documents. Furthermore, the server/client type systems can be implemented over WWW, because web servers can work together with database and file system. The trend toward system implementation over WWW leads to the web-based systems, which have been introduced in fields of education, research, business, medical services and social services by government. Thus, the web-based systems are becoming increasingly important in the various fields, because WWW breaks down the boundaries of operating systems pre-installed in the various types of the Internet accessible devices, and WWW is possible to be a platform in which a huge number of applications can be available.

To make such devices work for a particular purpose, suitable web-based system is necessary. This was the main target of this thesis, and the results described in this thesis demonstrated the actual system configuration, function blocks in the server and the local machine, and the applications for specific target, covering wide range of data processing in education, and measurements, control and monitoring in

engineering. The design and the particular configurations of the web-based systems are described together with the performance in the following chapters of this thesis.

In chapter 1, the outline of WWW history, and the present status of web-based systems were described briefly. The motivations were extracted and the 3 main study points were determined for the target web-based system to be data processing in server, control/monitoring and different applications cooperation. To solve the study points and realize the web-based system, a main configuration of the system was set for easy design of the actual system. These descriptions in chapter 1 show the background of the investigation to give an introduction of this thesis.

In chapter 2, the web-based academic system was described so as to make education and research activities in universities more efficient. The requirements on the system for supporting the activities were investigated, and the two sub-systems, which were education sub-system and research sub-system, were designed to fulfill the requirements. Furthermore the bilingual display function was proposed such that foreign users could participate in the academic system. The web-based academic system was implemented actually, having the teach-yourself set for education, remote measurement/calculation functions, the results display functions for research, and the exclusive access operation for simultaneous usages by a number of users. The performance is based on the data processing function of the web-based system. These functions are still in use at our laboratory, demonstrating the availability of the web-based academic system.

In chapter 3, the web-based plan-do-check trial supporting system was proposed such that students in universities could take the initiative in addressing the problem-based learning (PBL) efficiently. The system was designed so as to be able to conduct plan-do-check cycles for the PBL over WWW. The system was necessary to provide the functions by which the student could combine the experiments and theoretical calculations flexibly over WWW, because the students must learn through trial and error. The web-based plan-do-check trial supporting system was implemented, and the system performance was conformed to be successful in the experiment. The results clarified that the measurement functions were added successfully to the web-based system, enabling the students to measure characteristics of components appeared in their plan-do-check cycles over WWW. It was confirmed that the measurement function addition to the web-based system together with the data processing function could expand the applicability of the system.

In chapter 4, control/monitoring functions were added to the web-based system for the stackable ROADMs with optical amplifier, which was proposed so as to reconfigure the lightpaths to remove traffic congestions in IP-over-CWDM networks. The stackable ROADM contains the bidirectional optical amplifier module (B-AM), and it is judged by the web-based system whether the B-AM is used or not to amplify the optical signal transmitted through the network when the lightpaths are reconfigured. The stackable ROADM has also an optical power monitor (PM) to measure the optical power before entering an optical transceiver. The PM was controlled, and the monitored power could be obtained by the web-based system via the control/monitoring functions. It was confirmed that the stackable ROADMs with optical amplifier could reconfigure lightpaths for both cases with and without using B-AM by the implemented control/monitoring functions in the experiments. As a result, the added control/monitoring functions work properly in the web-based system.

In chapter 5, the flexible upgradability was evaluated by introducing a new application into the system to control a CO<sub>2</sub> laser and manipulator for fiber jacket removing. As described in chapter 4, the flexible upgradability is important for the web-based system to support wide variety of application. Thus, the new application for the jacket removing control was added to the web-based system without

re-programming the system function, and the performance was evaluated. By fabricating the compact fan-out adapters, it was clarified that the jacket removing processes were controlled successfully by the new application added to the web-based system. The results proved that the web-based system had the proper flexible upgradability. The performance evaluation also clarified that the new application for the control worked properly in corporation with other functions of the web-based system, i.e. data processing and data saving, because the control data were saved into the DB in the server.

In chapter 6, the results obtained by this research are summarized.

The wide range of applicability is essential to accelerate the introduction and usage of the system. This study can be expected to contribute to make such a web-based system useful in many aspects in social activities by implementing the system and showing the actual performance in different applications.

## 審査結果の要旨

本論文は、ネットワーク上での情報処理として基盤的な役割を果たしているウェブシステムを、更に汎用的な機能を持たせるため、ウェブブラウザをインターフェースとし、ウェブ上で制御と他のアプリケーションとの連携機能を持たせるため行った研究結果をまとめたものである。従来のウェブは、ウェブサーバでデータの蓄積と表示を行うものであるが、対象とする連携機能は、任意のアプリケーションを動作させるコンピュータをウェブサーバと接続し、ブラウザからウェブサーバを経由してアプリケーションを動作させ、結果を保存・表示させることでウェブ機能と連携させる機能である。同様に、制御機能は、制御対象とのインターフェースをウェブサーバに接続し、ブラウザからの制御と処理結果の表示をウェブ機能と一体化して行わせる機能である。本論文ではこれらの機能を設計し、実装することで目標とする機能が実現可能であることを実証している。得られた結果は、以下の項目に要約できる。

(1) ウェブサーバと連動させ、制御と他のアプリケーションとの連携が可能な一般的なシステム構成を提案し、必要な機能配分設計、制御と連携に対応したインターフェース設計を行い、全体のシステム構成を明確にした。この設計により、本システムの見通しが良くなると共に、更なる高機能化を行う場合に指針となる構成を提示している。

(2) 基本となるデータの蓄積と表示については、データを問題解決型の新しい教育手法に適用することを具体的な対象とし、システム機能を実装して機能が動作することを示している。この結果から、学生がシステムの機能を利用しながら Plan-Do-Check(計画—実行—評価)のサイクルを自律的に実行し、新しい教育に本システムが有効なことを示している。

(3) 制御については、波長多重光ネットワーク上で、ROADM (Reconfigurable Optical Add/Drop Multiplexer : 光パス再構築用アッド・ドロップ光多重装置)と光アンプを組み込んだ実験ネットワークにおいて、ROADM と光アンプを制御する機能を実装し、1か所の制御部からウェブブラウザをインターフェースとして制御することが可能なことを実証した。

(4) アプリケーションとの連携の例として、CO<sub>2</sub> レーザによる加工システムを制御するアプリケーションをウェブサーバと連携させる機能を実装し、対応する実システムで動作することを示した。本機能は制御とアプリケーションとの連携の両者を含み、得られたデータはウェブサーバに保存される一連の動作がこの研究結果から確認できている。

以上の結果は、ウェブ上で動作するシステムの有効性および適用先を増加させ、今後の情報の利用に対応する上で必要となる基礎的な技術を進展させており、本分野の学術および産業上の発展に寄与するところ大である。また、申請者が自立して研究活動を行うのに必要な能力と学識とを有することを証したものである。

学位論文審査委員会は、本論文の審査ならびに学力確認試験の結果から、博士（工学）の学位を授与することを適当と認める。