氏　　名	YOHANES YOHANIE FRIDELIN PANDUMAN
授与した学位	博　士
専攻分野の名称	工　学
学位授与番号	博甲第　　７１３４　　号
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学位授与の要件	自然科学研究科　　産業創成工学専攻 （学位規則第４条第１項該当）
学位論文の題目	A Study of Integrated Server Platform for IoT Application Systems （IoT アプリケーション・システムのための統合サーバ・プラットフォームに関する研究）
論文審査委員	教授　舩曳　信生　　教授　田野　哲　　教授　野上　保之

学位論文内容の要旨

This thesis presents the proposal of an integrated IoT application server platform called *Smart Environmental Monitoring and Analytical in Real-Time (SEMAR)*. *SEMAR* can be a cloud server for integrating various IoT application systems using different standards. It provides the standard features for collecting, displaying, processing, and analyzing sensor data from various IoT devices on a single platform. It can dynamically collect data from devices, process them, save them in the *Big Data* storage, and show them to users through a web-based user interface.

The first contribution of this thesis is the development of the standard functions in SEMAR. It offers *Big Data* environments with rich *built-in* functions for data aggregations, synchronizations, filtering, and classifications with machine learning techniques. Besides, *plug-in* functions can be easily implemented and added there without modifying the existing codes.

The second contribution of the thesis is the implementation of the *edge device framework* for *SEMAR* to remotely optimize the edge device utilization. It functions in the *initialization, service and update phase*. The edge configuration file includes the connectivity of sensor interfaces, a data conversion approach, a data model, filtering functions, transmitted data, local data storage, local visualization, and the data transmission interval on the server.

The last contribution of the thesis is the AI techniques integration into *SEMAR.* It presents an overview of current AI techniques and their use cases in IoT applications. First, I give a comprehensive review of AI techniques in IoT applications, which covers predictive analytics, image classification, object detection, text spotting, auditory perception, *Natural Language Processing (NLP)*, and collaborative AI. Second, I identify the characteristics of each technique by considering the key parameters, such as software requirements, input/output (I/O) data types, processing methods, and computations. Third, I design the integration of AI techniques into *SEMAR* based on the findings. Finally, I discuss the use cases of *SEMAR* for IoT applications with AI techniques.

This thesis is organized as follows. Chapter 1 presents the background and contribution of this thesis. Chapter 2 describes the architecture of the IoT application system. Chapter 3 presents the design and implementation of the integration functions in *SEMAR*. Chapter 4 presents the implementation of the *edge device framework* in *SEMAR*. Chapter 5 presents a comprehensive literature review of AI techniques in IoT applications with their use cases for designing AI techniques integrations in *SEMAR*. Chapter 7 reviews relevant works in literature. Finally, Chapter 8 concludes this thesis with some future works.

論文審査結果の要旨

In this thesis, the applicant presented the study of an integrated IoT application server platform called Smart Environmental Monitoring and Analytical in Real-Time (SEMAR). SEMAR can be a cloud server for integrating various IoT application systems using different standards. It provides the standard features for collecting, displaying, processing, and analyzing sensor data from various IoT devices on a single platform. It can dynamically collect data from devices, process them, save them in the Big Data storage, and show them to users through a web-based user interface.

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The applicant has published three journal papers and three international conference papers to present the contributions.

From the overall evaluation of this thesis, the applicant has satisfied the qualification condition for the doctor degree in Engineering from the Graduate School of Natural Science and Technology at Okayama University.