

New Information Service Solutions Utilizing Vending Machines

TAKAMATSU, Eiji* MORITA, Masahiro* TOKUMASU, Takumi*

ABSTRACT

Fuji Electric has developed a digital signage vending machine with an advertisement distribution system that can provide product images and advertisements as well as relevant market information as part of value-added services leveraging IoT. The vending machine displays advertisements and product images on the front screen, and it is coordinated with a content server. The control module is equipped with functions to control the switch of advertising content, connect applications and services, ensure secure network connection, update the product images on display, and gather and compile market information. It can also use visual data gathered using a camera to analyze and aggregate market information.

1. Introduction

In recent years, vending machine sales have been decreasing due to competition from large retailers and convenience stores. As a result, beverage manufacturers need their vending machines to be differentiated from those of other companies. To meet this need, Fuji Electric has been promoting the proliferation of digital signage vending machines since 2010 as vending machines that display product images on large displays.

The Japanese market for digital signage equipment has been increasing year by year. Furthermore, by the time of the Olympic and Paralympic Games Tokyo 2020, we expect that the demand for digital signage vending machines will grow greatly and double in number compared with 2017 (see Fig. 1).

Fuji Electric has been developing an advertise-

ment distribution system and digital signage vending machine that provide sales information while simultaneously displaying images and advertisements of products as a value-added service utilizing the Internet of things (IoT). This paper describes our new information service solution that utilizes this advertisement distribution system and digital signage vending machine.

2. Overview of the Advertisement Distribution System

Figure 2 shows an overview of our newly developed advertisement distribution system. Advertiser content is provided to the advertisement distribution system through an advertising agency. After this, it is delivered to each vending machine at a specified date and time by using the advertisement distribution function of the advertisement distribution system. Vending machines then combine the distributed advertisements and product images to display the content on the front screen.

The vending machine transmits the display his-

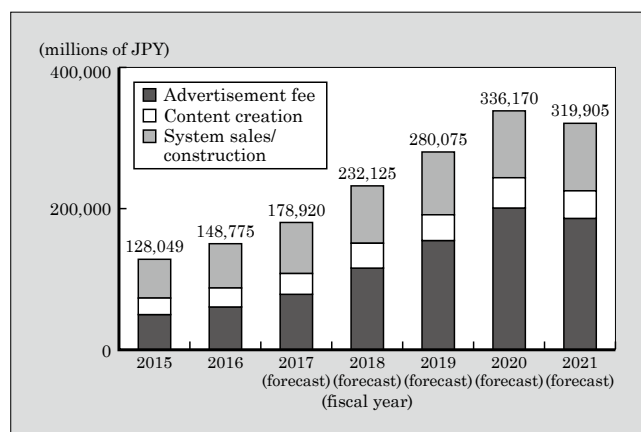


Fig.1 Market size for digital signage vending machines in Japan

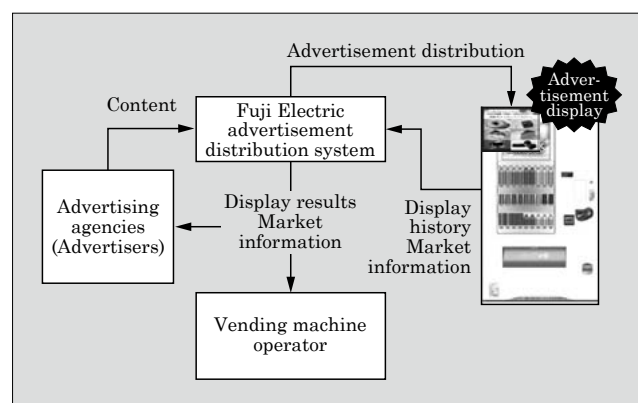


Fig.2 Overview of the advertisement distribution system

* Food & Beverage Distribution Business Group, Fuji Electric Co., Ltd.

tory of the advertisements to the advertisement distribution system, and the advertisement distribution system summarizes the display results in detail. In addition, market information collected and compiled by the vending machines such as sold products, sales date and time, and buyer gender and age group are transmitted to the advertisement distribution system and then provided to relevant persons such as advertisers, advertising agencies and vending machine operators.

3. Overview of the Digital Signage Vending Machine

3.1 Configuration and specifications

Figure 3 shows the configuration for the front of newly developed vending machine, and Table 1, an outline of the specifications. The vending machine has a basic configuration similar to that of vending machines for general hot and cold canned beverages and can hold up to 36 different types of products.

3.2 Advertisement display screen

The aspect ratio for the advertisement display screen is 1:1.78 as shown in Fig. 3, thereby enabling to display advertisements produced for mainstream full HD. Furthermore, the advertisement display section is arranged at the top of the screen so that advertisements remain visible even from a distance.

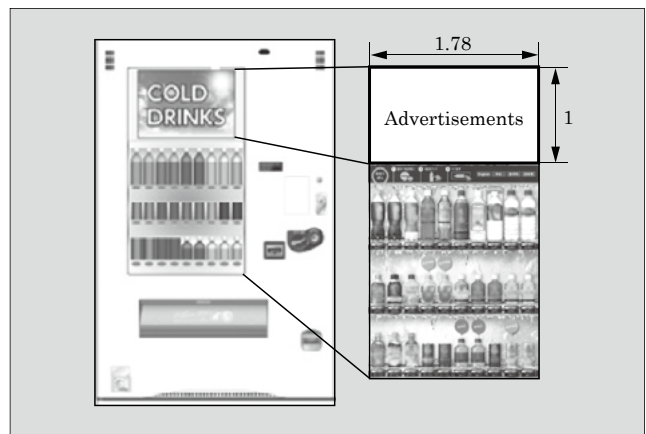


Fig.3 Configuration of the front of the vending machine

Table 1 Outline of the vending machine specifications

Item	Outline specifications	Function
Display unit	48-inch LCD display	For displaying products For displaying contents
Product selection unit	Touch panel	For selecting products
Camera	1.92 megapixels, color	For taking pictures for head-counts, attributes, etc.
Speaker	Power consumption: 3 W Quantity: 2 Size: φ50 mm	For playing advertisement BGM and messages to customers

4. Control Unit Functionality and Configuration

4.1 Overview of functionality

Figure 4 shows the functionality and configuration of the control unit. The advertisement distribution system consists of the following 5 functions:

- (1) Device guided advertisement content switching
The device controls and makes decisions on whether to acquire content or not.
- (2) Service connect engine (SCE)
The SCE is middleware capable of connecting applications and services on network.
- (3) Virtual private network (VPN)
The VPN ensures communication safety.
- (4) Content reassembly function
This feature updates the control functions for items such as images on vending machines.
- (5) Market information collection and compilation
This function uses the vending machine's camera to collect information on users in order to create market information.

4.2 Device guided delivery request function

For existing vending machines, site operators make various changes for each machine, including changing the background display, hot and cold display and rearranging prices and products.

Moreover, for each vending machine, its product assortment and advertisements are changed according to the season throughout the year. Furthermore, these changes pertain not only to management information but also with regard to installation, transport, and removal.

As a result, there are some things that cannot be determined via the cloud, such as ascertaining installation environments and selecting product arrangements and advertisements based on the environment. Therefore, in this system, we have constructed a management system whereby content can be automatically added or updated, and advertisement content can be manually changed according to the device guided decision of operators who are familiar with the settings

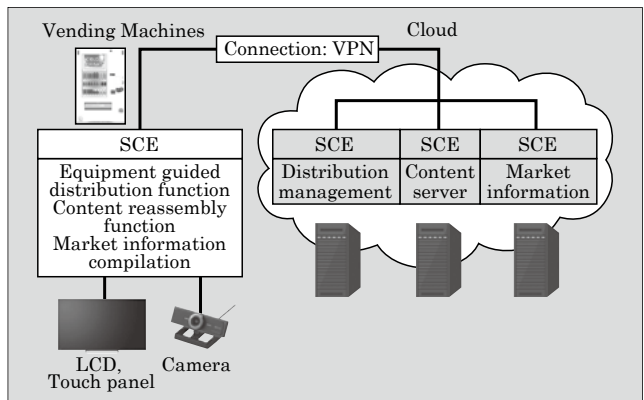


Fig.4 Control unit functionality and configuration

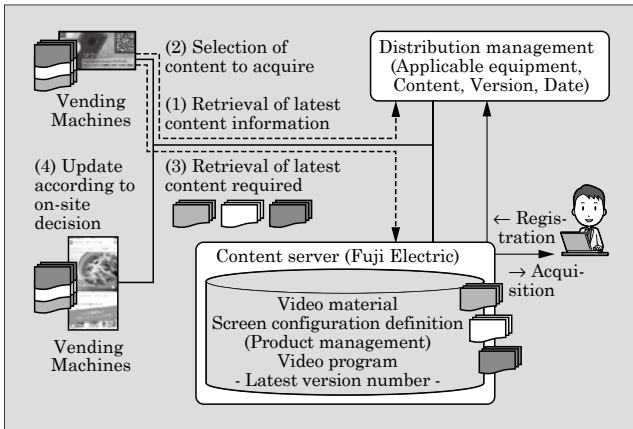


Fig.5 Overview of device guided advertisement switching function

and state of each particular vending machine. Figure 5 shows an overview of the device guided advertisement switching function.

- The vending machine retrieves the latest information from the list of distribution management content [see Fig. 5(1)].
- It determines the content to be acquired from information such as version number [see Fig. 5(2)].
- It contacts the content server to retrieve the content [see Fig. 5(3)].
- It enables site operators to manually or automatically update the content [see Fig. 5(4)].

4.3 Network application connected middleware (SCE)

As shown in Fig. 6, the SCE connects applications that were developed in different languages (Java^{*1}, C, etc.) on different hardware and on different operating systems.

Conventionally, the embedded software in our vending machines has run on middleware (software that acts as a bridge between the OS and the applications) that was independently developed by Fuji Electric using the programming languages such as C.

In addition to controlling sales and such in a manner similar to conventional vending machines through this middleware, the application developed this time controls the image display and touch panel features. Moreover, it also connects to other third party services provided in the cloud.

Therefore, we expanded the functionality of data-distributing middleware by enabling events to be shared between applications running on different hardware. By doing this, we have been able to achieve a lightweight middleware connection that focuses on the way services are called (service name, events, parameters) from applications running on the above-

^{*1}: Java is a trademark or registered trademark of Oracle Corporation and its subsidiary and affiliate companies in the United States and other countries

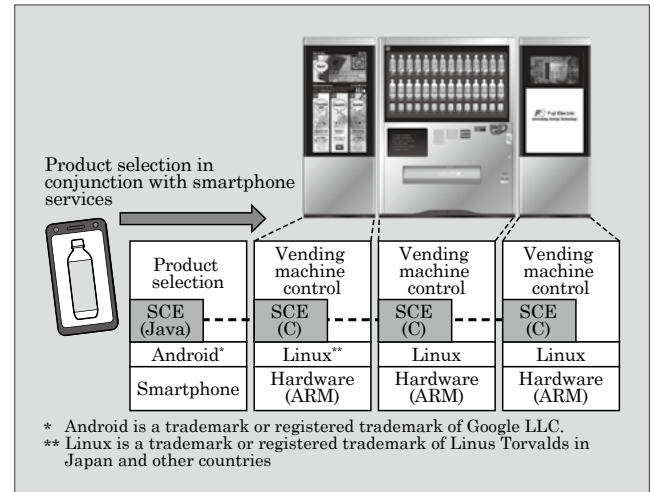


Fig.6 SCE concepts

mentioned middleware developed by Fuji Electric.

The SCE manages communication related services and protocols such as HTTPS. As a result, the SCE makes it possible for developers to create applications without being aware of what hardware the application or service will run on or what communications protocol it will use.

4.4 Virtual private network (VPN)

As a countermeasure against crimes such as tampering with or spoofing advertising content and product display images, the vending machine and servers are securely connected to the cloud and terminals using a VPN as shown in Fig. 7.

The VPN that we utilize this time is a software virtualization technology for LAN cards, communication channels and switching hubs. The main features are as follows:

- It is a low cost solution.
- It has a high file transfer speed.
- It makes 1:N configurations easy.

4.5 Content reassembly

The advertisement and product arrangement screen of vending machines is subject to many customer requirements such as those related to its operation, display effect, position, color and size. When designing applications that meet the various requirements of customers, we have separated and organized application features to eliminate complexity by adopting the MVC (model-view-controller) architectural pattern, which is known for its use in GUI design with object-oriented language. Screen-related applications consist of these M-V-C components: (1) the model component for managing data structures related to content display position, size and rotation, (2) the View component for managing the logic and assembly drawings (XML files) of various images displayed on the screen and (3) the control component for controlling the model component through external events. The content re-

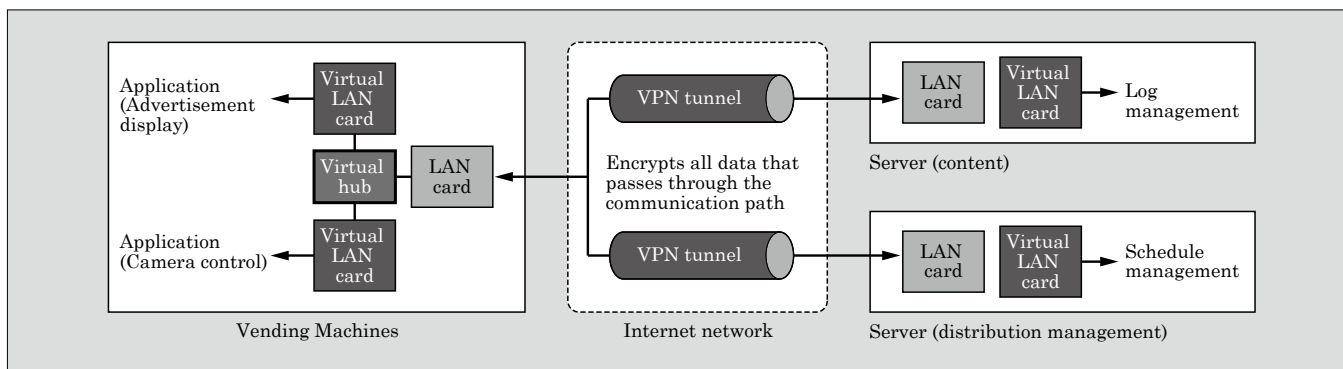


Fig.7 Example of software virtual VPN

assembly application enables the vending machine to update images with the content received from the advertisement distribution system based on assembly drawings when the operator updates or powers on the machine.

4.6 Collection and compilation of market information

Many digital signage systems unilaterally display images on the display. Therefore, an operator needs to stand near the machine to measure the effectiveness of the advertisements. In contrast to this, our recently developed vending machine automatically collects detailed market information that includes not only data on sold products and the time and date of the sale, but also the gender and age of the customer by using the built-in camera.

In addition, content providers such as advertisers are also interested in whether they can adequately appeal to potential customers using the displayed content. Therefore, the machine is also able to provide viewable information based on time, number of people, age, gender and eye gaze. This information is valuable to advertising agencies also when soliciting advertisers.

Furthermore, vending machine installation companies can predict sales by using the market information data and thus select appropriate product arrangements according to the location.

The built-in camera detects facial orientation and eye gaze for customers who want to ensure that their advertisements are being viewed. Moreover, from the viewpoint of personal information protection, only the following data is saved, which cannot be used to identify individual persons:

- (a) Number of persons
- (b) Age
- (c) Gender
- (d) Facial orientation
- (e) Eye gaze

Furthermore, market information can be analyzed and aggregated using the data collected by the camera (see Fig. 8).

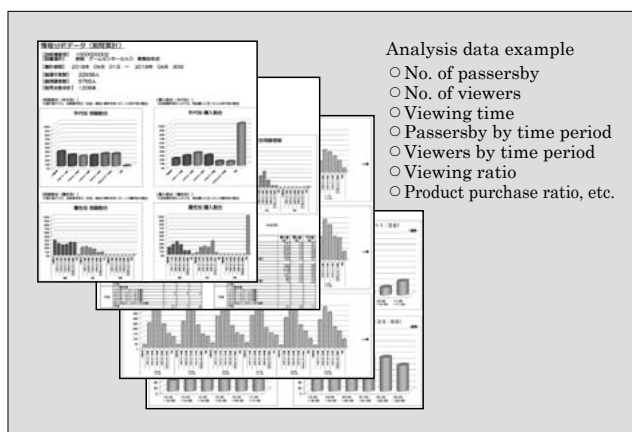


Fig.8 Experiment analysis charts

5. Implementation of Demonstration Experiment

In order to demonstrate the effectiveness of the advertisement distribution system, the vending machine was installed at an actual site to collect data as shown in Fig. 9.

In the demonstration experiment, we not only considered the effect of the presence or absence of advertisements, but also endeavored to establish a selection method for displaying advertisements based on market information.



Fig.9 Demonstration experiment unit

6. Postscript

In this paper, we described our new information service solution that utilizes vending machines. Using the advertisement distribution system that we developed can collect various types of market information.

In the future, Fuji Electric will be committed to even more precise sales forecasts employing multivariate analysis and probability inference, allowing our customers to achieve optimization in sales promotion by using future forecast in addition to the analysis results of collected data.





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