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# PERFORMANCE EVALUATION OF SIGHTSEEING CONTENTS CONSIDERING DIFFERENT USER COMPUTER SKILL AND DEVICES

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In our previous work, we already proposed a user interface switching function as a new concept of 'universal multimedia access' to narrow the digital divide by providing appropriate multimedia expressions according to users' (mental and physical) abilities, computer facilities, and network environments. The user interface switching provides a User Interface (UI) with appropriate operations and media according to their computer skill and computer facilities. In order to evaluate our approach for user interface switching, we have constructed sightseeing contents and introduce 28 spots in 6 prefectures of Japan providing 9 types of user interfaces in HTML5 and Java Script. In this paper, we discuss the performance evaluation for the sightseeing contents.

*Key words*: Multimedia Contents, User Interface, Sightseeing Information, Information Design.

## 1 Introduction

The universal design concept is proposed to support handicapped people in their social activities [1]. In the computer science field, the universal web [2-4] has been proposed to evolve this concept. However, this does not support switching of the contents, media or the Quality of Service (QoS) functions in order that devices and network environments work in their full performance. Many studies about QoS function have been conducted to optimize video quality for priorities on users' requests [5-10]. These studies focused on performances of devices and network environments but they did not consider users' abilities nor contents. There are also several studies on 'Universal Multimedia Access (UMA)' but they could not narrow the digital divide because they deal only with 'content switching' [11-13] and media quality [14-16].

In our previous work, we have already proposed a new concept of UMA and its switching functions [17-21] intended to narrow the digital divide by providing appropriate multimedia expressions according to users' (mental and physical) abilities, computer facilities and network environments. This paper describes multimedia contents to support the user interface switching function considering users skills and computer environments.

This paper is organized as follows. The user interface switching function is introduced in Section 2. Some examples of sightseeing information contents are presented in Section 3. In Section 4, we explain the system implementation. The performance evaluation is given in Section 5. Finally, Section 6 concludes the paper.

## 2 User Interface Switching

The digital divide is caused by the differences in users' personal competences, computer facilities and network environments with such detailed items as follows.

(1) Personal competence: Physical abilities for seeing, hearing and manipulating; linguistic literacy; computer skill and cultural background,

(2) Computer facility: Processing power, resolution, color quality, sound quality and battery life,

(3) Network environment: Bandwidth availability, specification and transfer mode.

Especially, User Interface (UI) provides users with appropriate operations and media according to their computer skill and computer facilities. Computer skill is evaluated as follows.

(G0) No Knowledge about Computer: Unable to operate any computer function.

(G1) Computer Beginner: It is able to start up the application software such as Web browser and play media.

(G2) General Web User: It is able to operate general Web pages and select to play a media.

(G3) Internet Expert: It is able to use efficiently interactive online applications such as a search engine.

On the other hand, computer facilities are rated from several viewpoints and classified into 4 levels (None, Low, Middle, High) to set up media.

The UI is provided differently according to computer skills and facilities. There are 9 types of UIs according to the mentioned computer skills and types of terminal devices as shown in Table I and Fig. 1.

Computer beginners are supposed to select Broadcast Operation (BO) in order to play media according to the program without complicated operations.

The user can get information just like watching TV because it is not necessary to operate any application software. Choice Operation (CO) is intended for general Web users in order to select media only. But, it takes much time to select one from a lot of media. Search Operation (SO) is supposed to support Internet experts by providing a keyword search function.

Table 1. UI according to user's operation and types of media.

| Operation | Media | | |
|---|---|---|---|
| | Text | Image&Text | Video |
| Broadcast | - No operation<br>- Displaying a text according to the program | - No operation<br>- Displaying images and text according to the program | - No operation<br>- Playing a video according to the program |
| Choice | - Selection<br>- Displaying a text according to the program | - Selection<br>- Displaying selected images and text | - Selection<br>- Playing a selected video |
| Search | - Keyword search<br>- Displaying a text according to the program | - Keyword search<br>- Playing searched images and text | - Keyword search<br>- Playing a searched video |

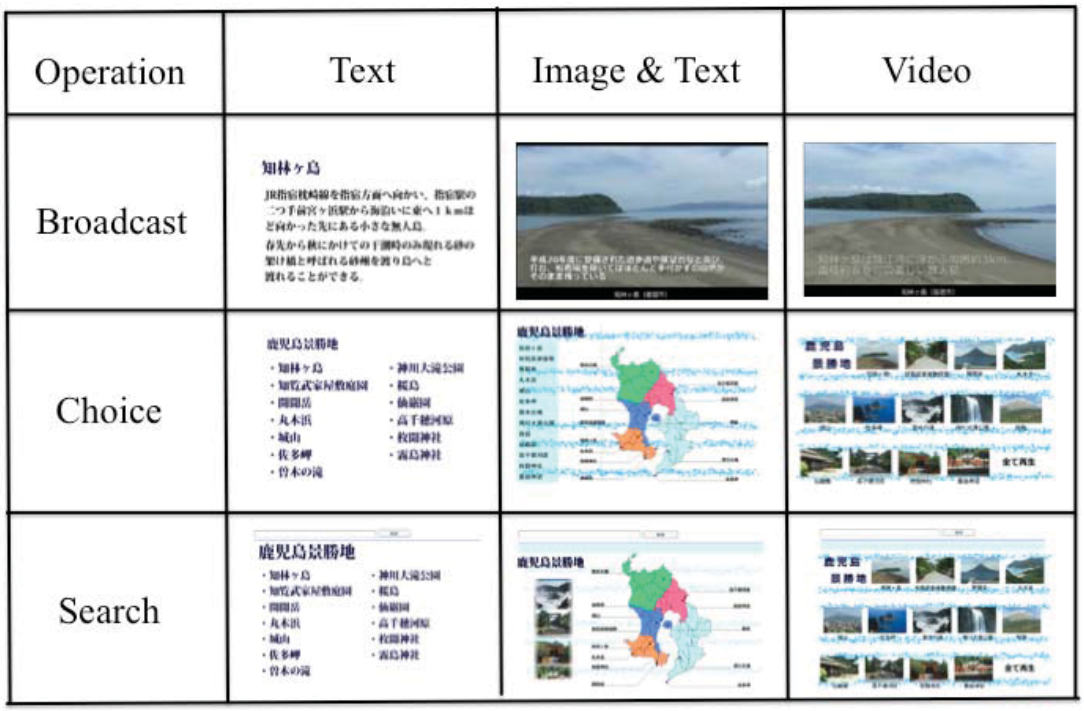



Figure 1. 9 types of UIs.

The low power terminals are supported to play text with low graphics power and narrow network bandwidth. The middle power terminals are used to display contents such as combinations of still image and text. The high power terminals play video. They require not only high power CPU but also high power Graphic device.

A layout is used to put media on UI and to specify the display region, display size and number of media for resolutions of the terminal device and media. These relations enable a layout to specify the display position according to the display size and the number of media.

For User Interface Switching (UIS), we focused on CO because the users are supposed to perform this operation when is needed. On the other hand, they will not use any operation without CO. From this reason, the CO is applied to UIS as one of controlling types of UI with buttons like TV remote control.

## 3 Sightseeing Contents

It is important to select for users the certain contents which fit to their desired sightseeing spots. In our proposed system, sightseeing information contents are played as shown Fig.2. The BO only plays contents randomly without complicated operations. The CO and SO play the contents with some choice operation and keyword search operation, respectively. Each media includes the information as follows:

(M1) Text: name, address, telephone number, introduction and supplementary explanation,

(M2) Image & Text: snapshot, map and same text as text contents,

(M3) Video: video and subtitle of a video with same text as text contents.

The contents can be changed to another type of the operation and media during playing.

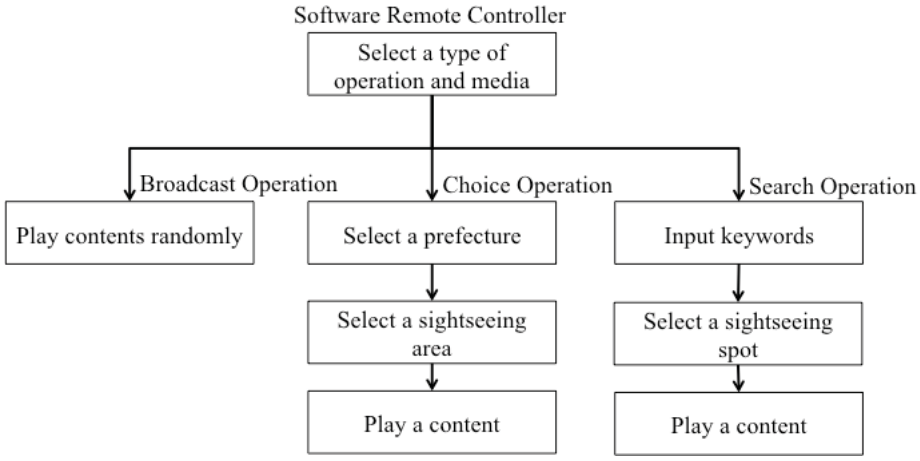



Figure 2. Flow of playing contents.

## 4 System Implementation

We implemented our system on Web Pages running on multi-devices as shown in Figs. 3, 4, 5, 6, 7 and 8 [22]. Currently, 28 spots in 6 prefectures of Japan are introduced to provide 9 abovementioned UIs. The implementation was developed on HTML5, CSS and JavaScript organized as shown in Fig. 9. The CSS files are used to define a layout of content within the page supported to multi-device and stored in the “css” folder. The display resolution is automatically switched to use the CSS “@import” rule defined as follows:

(R1) QVGA at narrow direction: screen width under 319 pixels width,

(R2) HVGA at wide direction: screen width over 320 pixels and under 479 pixels,

(R3) VGA: screen width over 480 pixels and under 639 pixels,

(R4) XGA: screen width over 640 pixels and under 1023 pixels,

(R5) FWXGA: screen width over 1024 pixels and under 1365 pixels,

(R6) FHD: screen width over 1366 pixels and under 1919 pixels,

(R7) WQXGA: screen width over 1920 pixels and under 2559 pixels,

(R8) QuadHD: screen width over 2560 pixels and under 3839 pixels,

(R9) Hiend: screen width over 3840 pixels.

The Java script is used to implement BO, SO and displaying the location for image & text content in which these files are stored in the folder “js”.

The BO plays media data randomly and displays the title, subtitles, texts, images and locations according to the progress of time. The sequence of activities [23] is different from each media as shown in Figs. 10, 11 and 12. The text content displays the title and some text at receiving “load” event and updates them at regular intervals as shown in Fig. 10. The image & text content displays the title, images, map and some at after receiving “load” event and updates them at regular intervals as shown in Fig. 11. The video content displays the title and plays a video at receiving “load” event and updates them at receiving “end” event caused by finishing to play video as shown in Fig. 12. Also, the subtitle is overlaid on the video using the CSS positioning properties such as relative positioning and update at regular intervals when the content receives “time-update” event. The SO supports the keyword search implemented by JavaScript and JQuery [24] and defines a table for database by “<table>” tag in HTML as shown in Fig. 13. The location is displayed with both the Java script and Google Maps API [25].

These UIs can be switched to the desired UI using ‘Software Remote Controller (SRC)’ as shown in Fig. 3. The SRC is used for general Web users in order to select a UI with simple button operation because other users would not like complicated operations.

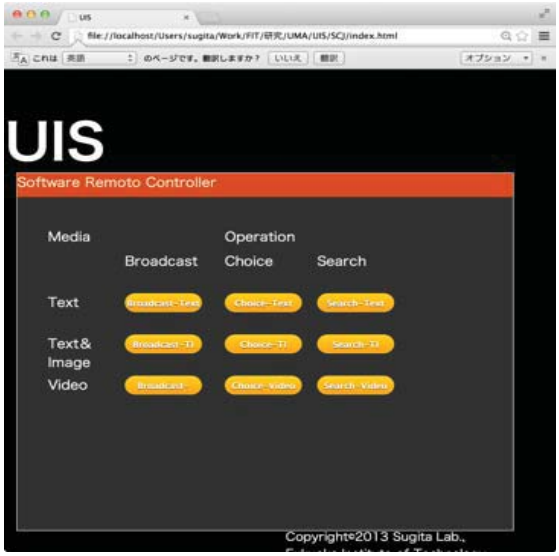



Figure 3. SRC.


(a) Text content (b) Image & text content (c) Video content

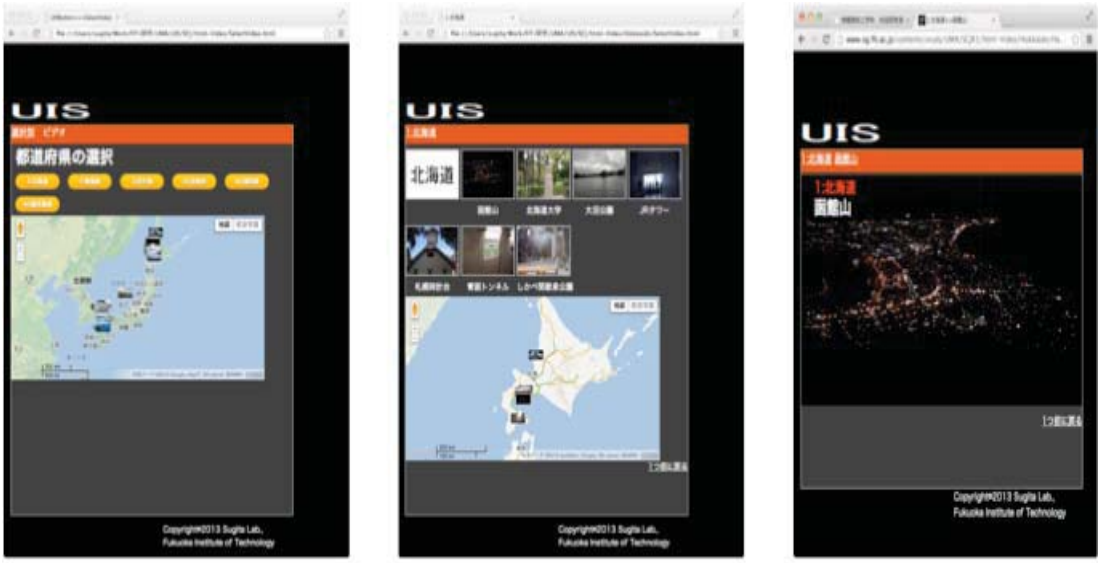
Figure 4. Implementation of BO contents.


(a) Choice of prefecture (b) Choice of spot (c) Display of content

Figure 5. Implementation of text CO contents.

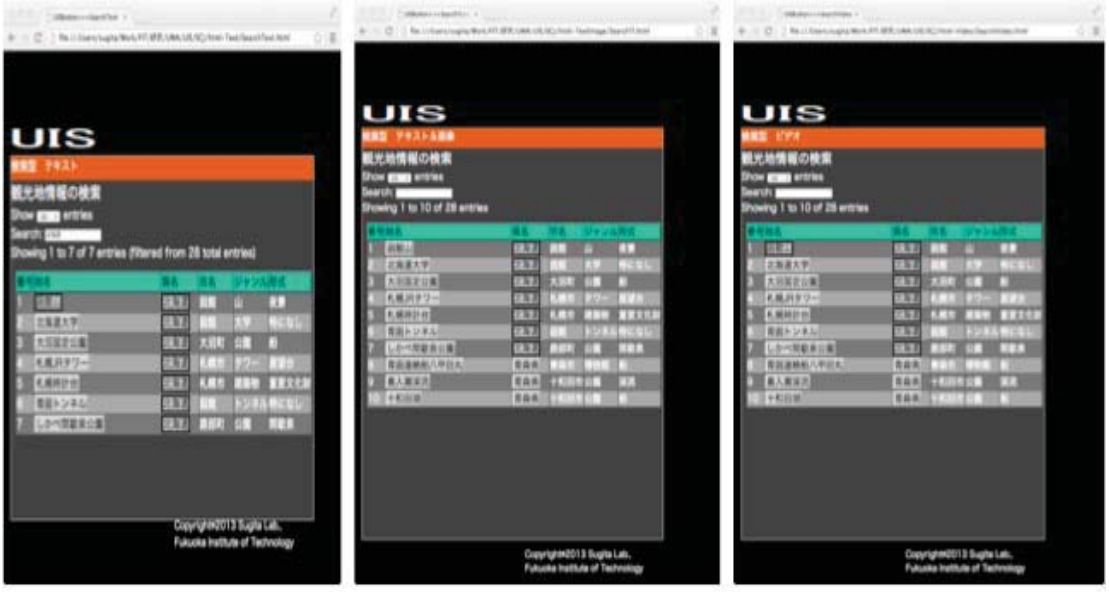

(a) Choice of prefecture (b) Choice of spot (c) Display of content

Figure 6. Implementation of image & text CO contents.




(a) Choice of prefecture (b) Choice of spot (c) Display of content

Figure 7. Implementation of video CO contents.




(a) Text content (b) Image & text content (c) Video content

Figure 8. Example of SO contents.

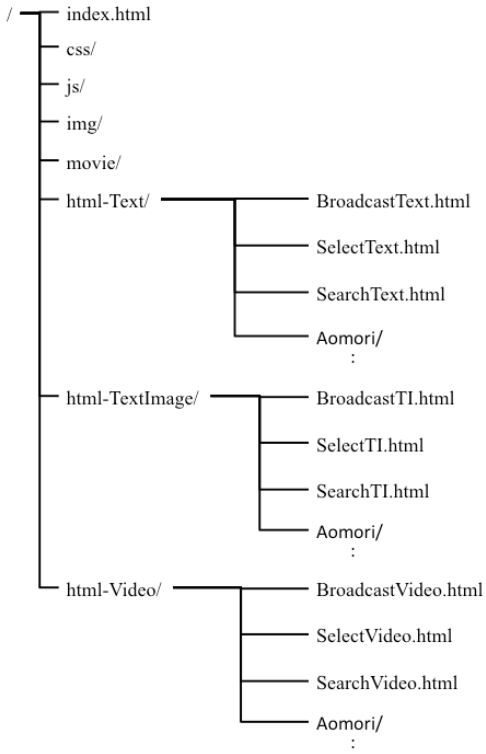



Figure 9. File organization of implemented system.

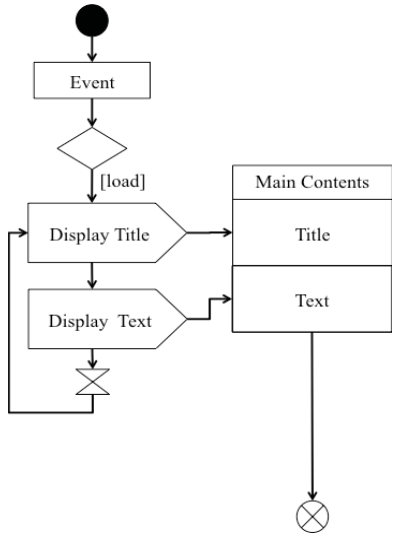



Figure 10. Activity diagram for text content supported by BO.

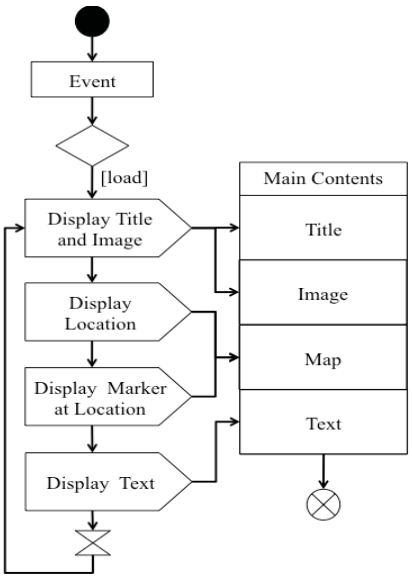



Figure 11. Activity diagram for image & text content supported by BO.

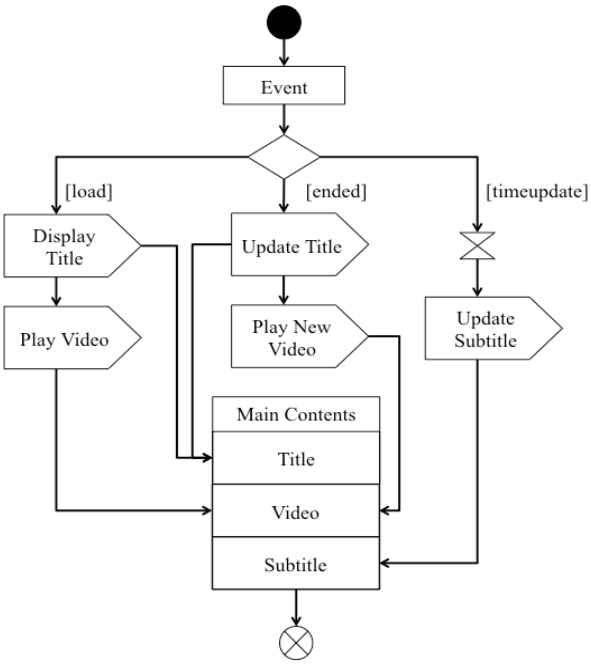



Figure 12. Activity diagram for video content supported by BO.


```
<script type="text/javascript" charset="utf-8">
        $(document).ready(function() {
                $('#example').dataTable();
        } );
</script>

<table cellpadding="0" cellspacing="0" border="1" class="display" id="example">
<thead>
        <tr>
                <td class="aaa">番号</td>
                <td class="bbb">地名</td>
                <td class="ccc">県名</td>
                <td class="ddd">市名</td>
                <td class="eee">ジャンル</td>
                <td class="fff">形式</td>
        </tr>
<thead>
<tbody>
        <tr>
                <td>1</td>
                <td><a href="Hokkaido/HakodateYama2TI.html">函館山</a></td>
                <td><a href="Hokkaido/SelectTI.html">北海道</a></td>
                <td>函館</td>
                <td>山</td>
                <td>夜景</td>
        </tr>
                                :
                                :
                                :
        <tr>
                <td>28</td>
                <td><a href="Kagoshima/kirishimajinguTI.html">霧島神宮(きりしまじんぐう)</a></td>
                <td><a href="Kagoshima/SelectTI.html">鹿児島県</a></td>
                <td>北薩</td>
                <td>神社</td>
                <td>特になし</td>
        </tr>
<tbody>
</table>
```

Figure 13. A part of source code for SO.

## 5 Performance Evaluation

CPU loads and throughputs during playing the contents were measured as shown in Fig. 14. Throughputs are measured data transmission rate using puddy_netperf when 2 PCs are playing the contents. CPU loads are measured during 10 minutes at every second by windows performance monitor. The specifications of PCs are given in TABLE 2.

When playing the content operated by BO, the throughput and CPU loads are shown in Figs. 15, 16 and Fig. 17, respectively. From the results, the video contents need the highest data transmission rate and the highest CPU load on the client PC but have some oscillations. The text and image & text contents have both low CPU load and data transmission rate, but they have no differences in CPU load and data transmission rate.

When the content operated by CO, the throughput and CPU loads are shown in Figs. 18, 19 and 20, respectively. In this evaluation, the contents were selected randomly. From the results, the video contents need the highest data transmission rate and the highest CPU load on the client PC. The image & text contents have low data transmission rate, but high CPU load periodically. The text contents have both the lowest CPU load and data transmission rate.

When playing the content operated by SO, the throughput and CPU loads are shown in Figs. 21, 22 and 23, respectively. In this evaluation, the contents were searched and selected also randomly. From the results, the video contents need the highest data transmission rate and CPU loads on the client PC. The text and image & text contents have both low CPU load and data transmission rate, but there is not any difference in CPU load and data transmission rate. On the server PC, all types of contents always have low CPU load and there are no differences.

Table 2. Specification of PCs.

| | PC1 | PC2 |
|---|---|---|
| CPU | Core i7 920 | Phenom II X4 945 |
| Memory | 6GB | 16GB |
| SSD | 120GB | 120GB |
| HDD | 3TB | 3TB |
| LAN | 1000Base-T | 1000Base-T |

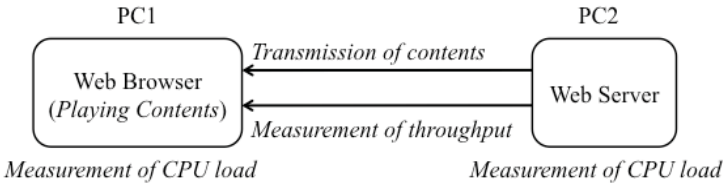



Figure 14. Environment of performance evaluation.

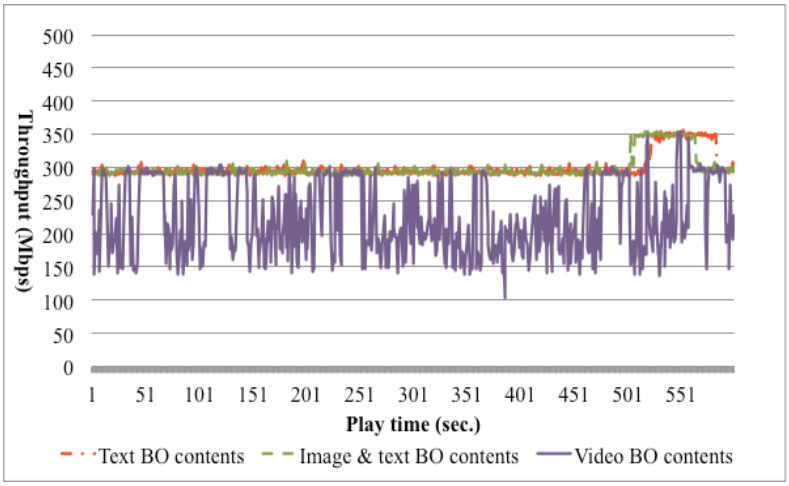



Figure 15. Throughput when playing the content operated by BO.

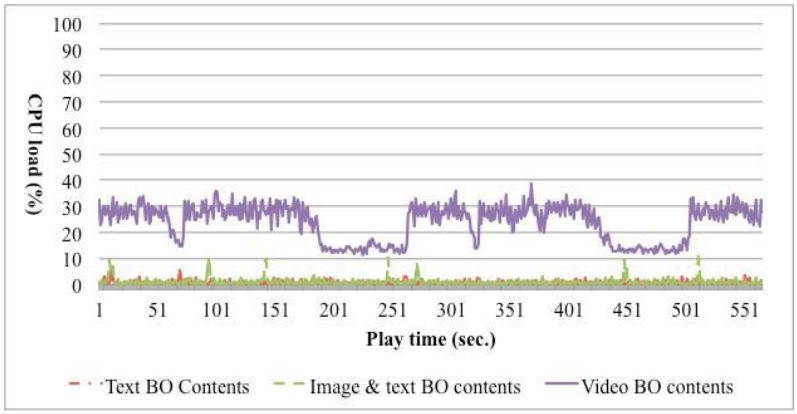



Figure 16. Client CPU load when playing the content operated by BO.

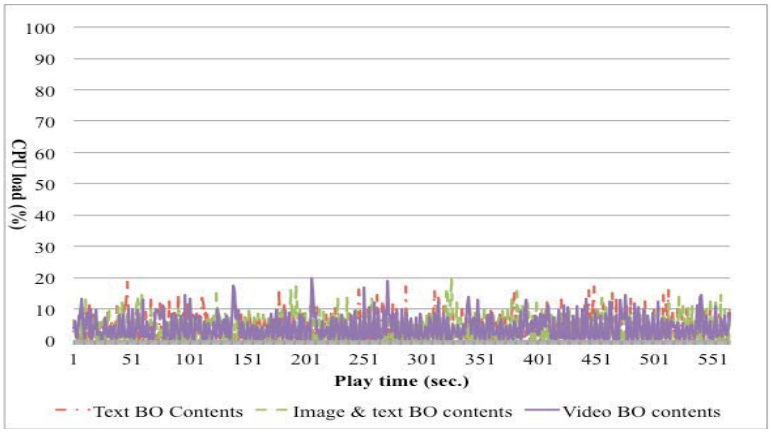



Figure 17. Server CPU load when playing the content operated by BO.

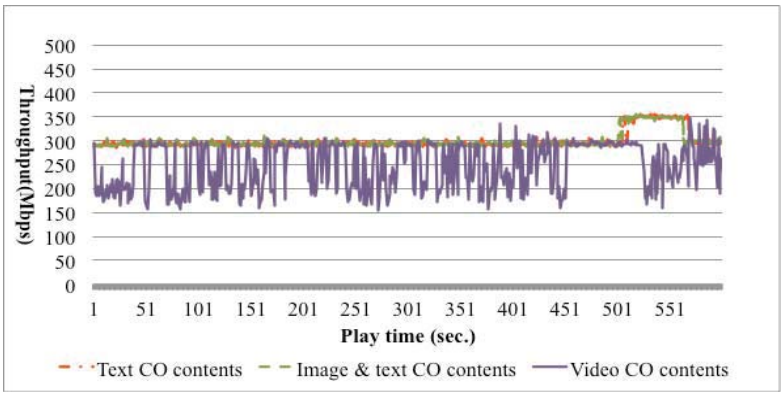



Figure 18. Throughput when playing the content operated by CO.

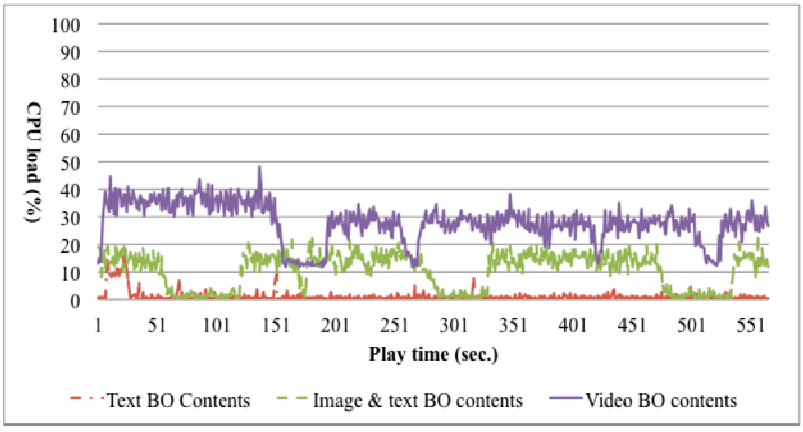



Figure 19. Client CPU load when playing the content operated by CO.

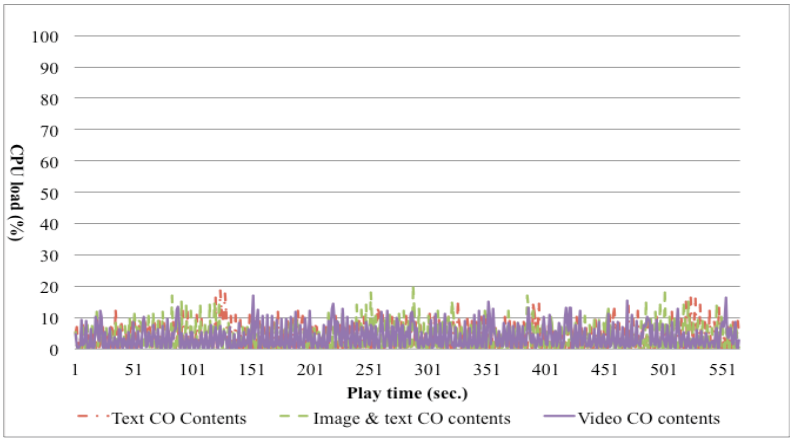



Figure 20. Server CPU load when playing the content operated by CO.

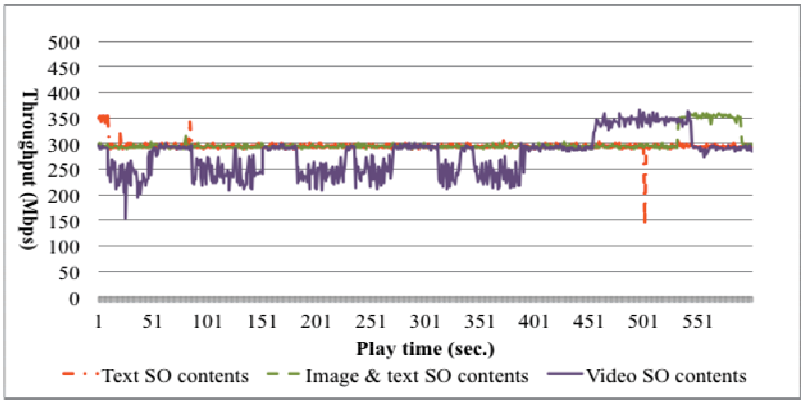



Figure 21. Throughput when playing the content operated by SO.

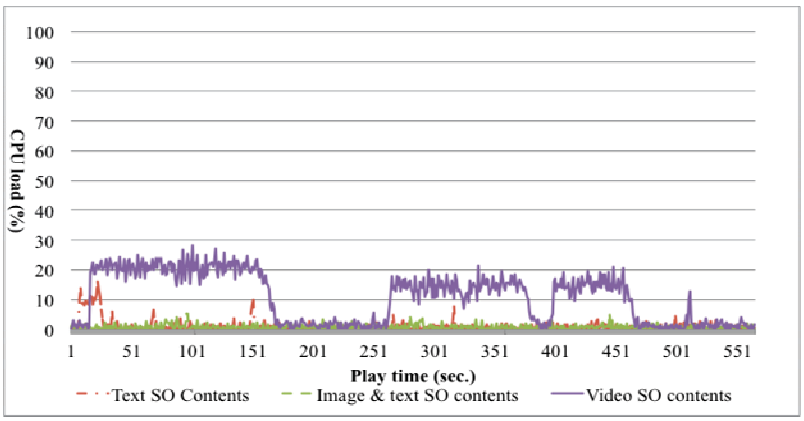



Figure 22. Client CPU load when playing the content operated by SO.

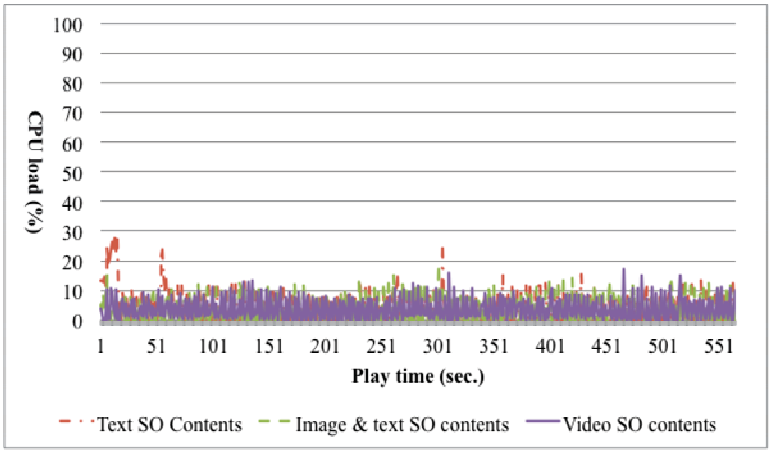



Figure 23. Server CPU load when playing the content operated by SO.

## 5 Conclusions

In this paper, we presented our implemented system and evaluated UIS and sightseeing contents in order to optimize the number of sightseeing spots. The implemented system can play 28 spots for 6 prefectures using 9 UIs supporting multi-resolutions. By the performance evaluation, we found the following results.

**When playing the contents operated by BO on the client PC**

(BOR1) The video contents need the highest data transmission rate and the highest CPU load but has some oscillations.

(BOR2) The text and image & text contents have both low CPU load and data transmission rate, but they have almost no differences in CPU load and data transmission rate.

**When playing the contents operated by CO on the client PC**

(COR1) The video contents need the highest data transmission rate and the highest CPU load.

(COR2) The image & text contents have low data transmission rate but high CPU load.

(COR3) The text contents have the lowest CPU load and data transmission rate.

**When playing the contents operated by SO on the client PC**

(SOR1) The video contents need the highest data transmission rate and CPU load.

(SOR2) The text and image & text contents have both low CPU load and data transmission rate, but they have almost no differences in CPU load and data transmission rate.

Furthermore, all types of contents always have low CPU loads (with almost no differences) on the server PC.

In the future work, we will carry out questionnaire surveys for different types of persons. Also, we will increase and internationalize the contents.

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