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# Development and use of a digital signage system for revitalizing regional shopping districts

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# Development and use of a digital signage system for revitalizing regional shopping districts

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**Abstract:** In Japan, regional shopping districts are on the decline because residents prefer suburban-type large-scale shopping stores. Such issues can be addressed in the context of the "Smart City", of which functions depend on the information and communication technology (ICT). We established the "KIT Digital Signage Project," which aims to help the regional stores around the Kanazawa Institute of Technology (KIT). In our project, we developed a digital signage system that is low-cost and easy to introduce in small stores. We conducted an experiment to evaluate the effect of our system. During the experiment, store-advertising movies were shown on digital signage terminals, which were placed in each store. The total average watching time and audience rate of our system were 24 s and 50%, respectively. In addition, we investigated the educational aspects of our project. The students in our project could master movie production in a shorter time when compared against learning it as an ordinary classroom subject. The future plans of our project are also discussed.

Keywords: Digital signage; Regional revitalization; OJT; Project-based learning

**Biographical notes**: Shota Takata and Kengo Hayashi are currently students of the Graduate Program in System Design Engineering, Kanazawa Institute of Technology. This study is based on their graduation thesis.

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#### 1. Introduction and background

"Shutter Street" is currently a common problem in the shopping districts of many regional Japanese cities, where many closed-down stores exist with gate shutters permanently rolled down. This decline of shopping streets sometimes occurs in the center of regional cities because of the "Doughnut Phenomenon," wherein the population decreases in the city center while it increases in the surrounding regions. Furthermore, city residents prefer to visit suburban-type large-scale shopping stores, which have large parking lots. Fushimidai shopping street (FSS) in Kanazawa city, the nearest shopping street to the Kanazawa Institute of Technology (KIT), is likely to face this situation. Since many KIT students depend on FSS, its decline would directly impact them.

Recently, "Smart Cities", which provide information and communication technology (ICT) solutions for many issues arising from rapid urbanization, received attention (Nam & Pardo, 2011). The above "Shutter Street" issue is related to the quality of life of the citizens and the economy of the city, which are important factors for the smart city initiatives (Chourabi et al, 2012). Thus, we planned to support FSS in the context of the "Smart Cities".

The Department of Media Informatics at KIT intends to foster the digital content skills of its students. The department has a prerequisite subject named Media Informatics Major Lab/Exercises B (MIMLEB) for third-year students; it includes learning the production process of digital movie content. In the MIMLEB course, the students are divided into groups, allowed to independently decide the theme of a movie, and produce the movie. Despite this program showing positive results so far, the movies produced by the students often tend to be trivial and self-indulgent. To provide the students with more practical experience in digital movie production and to revitalize FSS, we considered allowing students to produce advertising movies for the FSS stores. However, produce them through the MIMLEB course was difficult; therefore, we instigated a project-based course named the "KIT Digital Signage Project" to produce advertising movies and

deliver them through a digital signage system that we developed for the use of the project. In the following section, we briefly review the concept of digital signage.

#### 2. Overview of digital signage

In recent years, digital signage has progressed rapidly. Unlike a conventional static signboard, digital signage can display dynamic movies. As publicity media, this is an advantage because movies attract the human eye more than still images because of the human instinct to track moving objects. Moreover, the recent price reduction in liquid crystal displays (LCDs) and the progress of internet have contributed to the spread of digital signage.

Nakamura (2010) indicated that digital signage will be the fourth most common media that will fill the niche in existing media. Traditionally, the three types of common media have been TV (indoor/push type), PC and Web (indoor/pull type), and Mobile (outdoor/pull type), as shown in Fig. 1. Therefore, digital signage, which is an outdoor/push type media, can fill this niche and is a possible candidate for the next generation of popular media.



Fig. 1. Position of digital signage

The most popular and successful digital signage system in Japan is the "Train Channel" of East Japan Railway Company (Train Channel, 2014). "Train Channel" display equipment is installed in some trains, and passengers can view push-type content, such as news, videos, and advertising. The attention and reach rates of "Train Channel" are 11.8% and 37.6%, respectively (Train Channel, 2014). Such digital mass publicity appears to be valid only in urban areas, although there are a few successful examples of digital signage in regional areas. Nakamura (2010) referred to the possibility of digital signage as a revitalization tool for regional areas. To optimize this opportunity a more individual (not mass) approach should be used to attract the fewer residents in the vicinity. To realize the above, a simple, low-cost but sufficiently functional system was developed. In the following section, we introduce our system in detail.

#### 3. Our system

Many digital signage products and solutions are available currently. Despite their rich features, such systems appear to be uncommon because they are often expensive. A similar situation once arose in the field of e-Learning; the spread of e-Learning in Japanese universities was relatively delayed compared with its adoption by companies. Therefore, we decided to develop an original digital signage system. Our system has no software expense because it is based on open-source software. An android stick terminal for the client costs only around \$50, and the signage display can be an ordinary highdefinition multimedia interface (HDMI) connectable TV, which is becoming cheaper. Fig. 2 describes the outline of our system. The server-side web application manages the client information, distribution, and scheduling of content. The client is an android native application that pulls content from the server and plays them according to a JavaScript Object Notation (JSON) format playlist, which is downloaded from the server and stored in the local SOLite database. Each movie is downloaded from the server using an HTTP pseudo-streaming function, enabled by the H264 Streaming Module (Codeshop, 2014) of Apache httpd. This is a normal network mode operation, but the client will automatically switch to standalone mode when it detects network disability. The content and playlist must be saved in the client local storage before standalone mode operation.



Fig. 2. Outline of the proposed system

#### 3.1. Server side

The Linux–Apache–MySQL–PHP environment is chosen for the server. The server application is based on a CakePHP framework (CakePHP, 2014) and designed by a Twitter Bootstrap template (Bootstrap, 2014). The server application provides three main functions: content management, playlist management, and client management. Authentication and management of users is also available.

#### Content management

The main menu of the content management function is shown in Fig. 3. All the existing movies are listed and the user can preview and delete them or upload a new movie.

Adsign管理システム	合 Home ■ 端末管理	🖍 素材管理 🧧 プレイリスト管理	◆ マスタ管理 -	林謙吾▼
素材管理 - 配信素材を管	理します			
✔ 新規追加				
投稿日	タイトル	ファイル名	操作	
2013-11-23 18:42:32	テスト素材	gd.mp4	◎ 詳細 📕	前削除
2013-11-23 21:41:07	テスト素材②	big_buck_bunny_720p_surround.mp4	◎ 詳細 【	前削除
2014-01-17 11:12:37	北國ローン_15sec	.mp4	● 詳細   [1	前削除
2014-01-21 12:16:16	日赤_Bパート	nisseki.mp4	◎ 詳細	前削除

Fig. 3. Main menu of content management

#### Playlist management

Fig. 4 shows the main menu of the playlist management function. The playlist contains the order and schedule of content delivery. Using the playlist editor (See Fig. 5a), the user can add/edit the framework (title, delivering terminal, description, and schedule) of the playlist. After the submission of the framework, the user adds the movies in playback order by using the movie addition menu (See Fig. 5b).

Ads	ign管理シ	vステム 合Home 冨端	末管理 📝 素材管理 📑 プレイリスト管理	✿ マスタ管理▼	1			
配	<b>配信管理</b> - 配信リストを管理します							
	新規登録							
id	登録者	タイトル	詳細	登録日	操作			
2	林謙吾	伏見台商店街 テスト	伏見台商店街用のプレイリスト	2013-11-25 00:06:50	● 詳細 📝 編集 🔒 削除			
3	林謙吾	aaaaaaa	aaaaaaa	2013-11-25 00:28:46	● 詳細 📝 編集 📄 削除			
5	林謙吾	テスト配信	テスト配信!	2013-11-25 13:25:50	● 詳細			
6	林謙吾	テスト	あああああああ	2013-11-25 14:05:25	● 詳細			
7	林謙吾	TTTEEEEE	Алалала	2013-11-25 14:05:48	● 詳細 📝 編集 👔 削除			
8	林謙吾	efcvsmfkl;fsdsvdfv	ddddddd	2013-11-25 14:06:13	● 詳細 📝 編集 💧 🏛 削除			
9	林謙吾	テスト!	АААААА	2013-11-26 01:01:23	● 詳細 📝 編集 🔒 削除			
10	林謙吾	テスト配信	テスト配信	2014-01-12 18:15:48	● 詳細 📝 編集 📄 削除			
11	林謙吾	TEST	AAAAAAA	2014-01-20 00:40:53	● 詳細			

Fig. 4. Main menu of playlist management

#### **Client management**

The main menu of the client management function is presented in Fig. 6. The user can add/delete clients from this menu. Terminals are identified by Terminal ID, which is included in the HTTP GET request from the terminal.



– Submit

登録

(b) Movie Addition

Fig. 5. Menu to edit/Create a playlist

Ads	ign管理システム	🔒 Home	〓 端末管理	🖌 素材管理 🛛 🖺 プ	レイリスト管理 🛛 🕈 マ	'スタ管理▼	上 林謙吾▼
		-					
配信先デバイス管理 - 配信デバイスを管理します							
id	デバイス追加		祭结本	⇒¥ ≰Ⅲ	彩绘口		1. JA
id	新大IN*		豆짜有	計加口	豆漱口	1	DRTF
1	CX5562618		林謙吾	テスト端末 確認後消去	2013-11-24 22:14:2	1	<b>前削除</b>
2	JSKKKKAAaAAAAA		林謙吾	テスト端末	2013-11-24 23:15:4	9	<b>前削除</b>
3	NNNHHSSSSSAAAA		林謙吾	テスト端末	2013-11-24 23:16:0	6	<b>論 削除</b>

Fig. 6. Main menu of client management

#### 3.2. Client side

Client software is built as a native application for Android 4.x. Its main functions are as follows: (1) detect network connection and switch to standalone mode when there is no network; (2) get JSON format playlist from the server using volley library (Volley, 2014), or from local storage if it is in standalone mode; (3) save schedule data into local SQLite database; and (4) play movies with VideoView API, according to the schedule described in the playlist. Fig. 7 shows the screenshot of the client (Android tablet) playing a sample movie.



Fig. 7. Screenshot of the client application

# 4. KIT digital signage project

#### 4.1. Concept

As mentioned in Section 1, we established the "KIT Digital Signage Project," which aims to revitalize regional shopping streets and improve students' digital movie production skills. We reinterpreted digital signage as a media to promote the mutual guidance of customers between the regional stores. Fig. 8 illustrates the main idea of our project. For example, a hair salon and a cake shop belong to different shop categories, but the target consumers are similar (i.e., young women). If we establish a partnership between these two stores and place signage terminals, which display advertising movies of the partner store, the mutual exchange of customers might be realized, potentially causing an increase of customers in both stores. With this concept, we started the project activities at FSS in September 2013.

#### 4.2. Project activities

The initial members of the Digital Signage Project were seven volunteer KIT students. The seven steps in the project activities are listed below:

- 1. Meeting at the Store
- 2. Making a Storyboard
- 3. Presentation and Discussion at the Store
- 4. Interview and Camera Shooting
- 5. Authoring
- 6. Preview
- 7. Actual Operation

Here, we observe that minimal training of business protocol and film grammar (Manchel, 1990) for the students was performed before the project began. Because the student project members have a mission to satisfy the store owner and staff with their movie, their learning attitude is quite serious compared with their approach in classroom subjects. Moreover, the continuous discussions between the members, store owner, and staff (steps 1, 3, 4, 6, and 7) cultivated the students' communication skills. Fig. 9 shows an example of step 4, a snapshot of the camera shooting the advertising movie for a Japanese noodle restaurant, Ten-Ichi Ya, in FSS.



Fig. 8. Concept used in the digital signage project



Fig. 9. Camera shooting of an advertising movie

We obtained cooperation from ten stores, including a bank, a post office, and a hospital, in FSS. The student members produced ten short advertising movies for each of the ten stores. Unfortunately, due to lack of space, four stores declined to place the display. The movie program, optimized for each of the six stores, was completed on December 10, 2013. The average running time of the movies was approximately 3 min. The test run started on December 15, 2013 and continued until the end of February 2014.

#### 4.3. Terminal equipment

The terminal equipment chosen for the use of the project consists of a 21–24 inch LCD display (Fig. 10a) and an Android stick, MK808B Mini PC, which is inserted into the HDMI jack of the display (Fig. 10b). We installed our client application (described in Section 3) on the sticks and configured them in such a way that it starts the application automatically in standalone mode when they were turned on, because some stores had little or no internet connection. The programs and movies stored on the micro SD cards inserted into the sticks were not changed during the duration of the actual operation.



(a) Digital Signage Display



(b) Android Stick

Fig. 10. Terminal equipment

#### 4.4. Results of the evaluation experiment

A one-day observation at four stores to monitor the watching time and audience rate of our movies was conducted in the middle of January 2014. The results are listed in Table 1. The audience rate is the ratio of the number of watchers who watch the content for over 5 s to the total number of visitors. The total average watching time is 24 s, and the total average audience rate is 50%. We determined that our 3-min movie content may be long because visitors paid attention to them for only a few seconds. The audience rates at the pharmacy and hospital were remarkably large, probably because we placed the terminal in the waiting rooms where visitors stay for extended periods.

#### Table 1

Average watching time of visitors and audience rate of our digital signage system

Store	Average Watching Time (s)	Audience Rate (%)
H Bank	35	27
G Supermarket	10	20
A Pharmacy	25	81
R Hospital	27	72

Interviews were conducted to ask store visitors for their impression of the system. Some of the comments are as follows:

- I want to go to the store when I have time.
- I am comfortable with this content.
- I am interested in the store because now I understand the personality of the owner and the staff of the store.
- This movie catches my eye because I have never seen such a display here.
- This may be a good way to kill time.
- I cannot read the caption in the movie because it is too small.
- I cannot watch all the movies though I want to. It is too long.
- A display of profitable information, such as a coupon, may gather more visitors.

The responses from the visitors and the store owners are mostly favorable enough to encourage the student project members. This also raises the students' learning motivation, which is considered to be intimately related to the educational effects.

#### 5. Educational aspects of the project

In Section 1, we mentioned that the KIT Digital Signage Project has two objectives, i.e., revitalization of the region and improvement of digital movie production learning. This section concentrates on the educational aspects of our project.

#### 5.1. Theoretical background

The KIT Digital Signage Project is a type of project-based learning (PBL), which is an on-the-job-training (OJT)-like initiative at the university; it has been attracting attention (Mincer, 1962; Blumenfeld et al., 1991; Barron et al., 1998). Usually, the theme of PBL is practical solutions to problems, through which the students can acquire the type of experience that is not realized in conventional classroom teaching. Experience is the key aspect of PBL. Kolb (1984) advocated his successful experiential learning model, which consists of a cycle of the following four steps: concrete experience, reflective observation, abstract conceptualization, and active experimentation. The importance of the experience is supported further by Lombardo and Eichinger (2000), who showed that 70% of effective learning by employees is the result of practical jobs. Because the steps described in subsection 4.2 resemble those of professional content management film production, our project can provide student members with a highly practical experience of movie production.

#### 5.2. Questionnaire results and evaluation

After our experiment, we assigned the project members—except the project leader, who is one of the authors of this study—a questionnaire to investigate the educational aspects of the project. The questions are as follows:

- Q1: The number of movies I have produced before the project.
- Q2: My average total elapsed time to accomplish movie production.
- Q3: My interest in movie production is greatly enhanced through the project activities.
- Q4: My skill in movie production is greatly enhanced through the project activities.
- Q5: I am very satisfied with the project activities.

The answer choices for Q3 to Q5 are described by a five-point Likert scale (1: Strongly Disagree, 2: Disagree, 3: Undecided, 4: Agree, and 5: Strongly Agree). The results are summarized in Table 2. Despite almost all the students being only 19 years old with no experience in movie production before PBL, they could accomplish movie production within 7 h after six months of PBL, while students of MIMLEB, which is for students aged 21, took 24 h. In addition, almost all members answered that they were satisfied with this project and that their interest and skills in movie production were enhanced. Student B appears to be an exception, but he already had prior movie production experience. Therefore, he probably did not feel that he improved as much through the project.

Table 2Questionnaire results

Student	Age	Q1	Q2	Q3	Q4	Q5
А	19	0	5 h	4	4	4
В	19	3	2.5 h	3	3	3
С	19	0	7 h	3	4	3
D	19	0	4 h	4	4	4
E	19	0	6 h	4	5	5
F	22	0	2 h	5	5	4

#### 6. Conclusion

This study developed a web-based digital signage system for revitalizing regional shopping districts. Our system realizes a simple and low cost but sufficiently functional digital signage environment. The test run was successful, and the results of the evaluation experiment were mostly favorable. However, we have not tested the network mode. During the test run, we fixed the movie playlist because the project duration was rather short, around two and a half months. However, this is not feasible for practical long-term operation when network mode must be chosen. Currently, our system can only handle H264-encoded movies due to the restrictions of the H264 Streaming Module. This difficulty may be fixed if we revised the server application in the manner of Ruby on Rails. Because the people of FSS are eager to continue the digital signage display, we are now improving the system and redesigning the project to manage more students and stores.

The educational effect of our project was also examined. We determined that the members of the project took a relatively short time to master the operation of the authoring tools and to accomplish movie production compared with the regular subject in MIMLEB. In addition, we confirmed that almost all the project members were well motivated, encouraged, and satisfied by the activity. However, we must observe that the project members were only a small number of voluntary students whose motivation was relatively high from the beginning. Therefore, the outcome of PBL cannot be exactly compared with a classroom subject, which is oriented toward mass education. The adaptation of PBL to mass education might be difficult but worthwhile considering.

There are other possibilities for the educational application of our system. Recently, the number of universities that consider "student satisfaction" (SS) viewpoint appears to be increasing. Because of the current decline in the number of 18 year olds, universities must differentiate from each other to meet their quota. In addition, SS affects the educational experiences of students, because a high SS will motivate them to learn more. Elliott and Healy (2001) indicated that the key factors of SS are student centeredness, campus climate, and instructional effectiveness. Here, we concentrate on the second factor, i.e., campus climate. If the students can easily obtain useful information and heart-warming encouragement in common campus spaces, their convenience and satisfaction may increase. Hence, a digital signage system can contribute to SS to some extent. In fact, there are some digital signage products aimed at use in university campuses. For example, Visix Inc. in the U.S. provides its digital signage software to over 700 campuses (Visix, 2014). In Japan, Dai Nippon Printing Co., Ltd. releases "Campus TV," which provides news and useful information for university students (Campus TV, 2014), and Panasonic Co. (Panasonic, 2014) and SHARP Business Solutions Co. (SHARP, 2014) produce campus digital signage solutions. However, such products are very expensive for universities. Although we originally planned to contribute to regional revitalization, our system can be a general, multipurpose digital signage platform. Therefore, our system can also be adapted to campuses. Moreover, our project members may produce attractive content from students' viewpoint. Those contributions to learning appear to be indirect, but a direct application of our system to education is also feasible. For example, our system can be used as a simultaneous lecture movie distributor to multiple classrooms.

Some cases which treat digital signage systems as a part of smart city infrastructures have been studied so far. For example, Filipponi et al. (2010) implemented a projection-type signage system for a public alert system in their smart city project. Kohno, Masuyama, Kato, and Tobe (2011) illustrated the smart city solutions of Hitachi

Co. LTD. in Japan including signage systems for a smart navigation. Our digital signage system can also be involved in the smart city infrastructures. In addition, our system will provide the enhancement of smart communications between city residents as a new generation information media. In fact, we are now planning to extend our project around the area and inside KIT. The content will not only be advertisements but also various types of movie for residents and students. Such movie distribution will be similar to TV broadcasting, but in this case, the effective service area is limited to a small district. The spread of future high-speed wireless WAN/LAN environments will encourage our trial. An implementation of bidirectional/interactive communicative functions and devices for our client terminals is also a worthwhile consideration. We hope that our digital signage environment will become a novel regional community media and will support the revitalization of the region.

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