Development of the Travel Diary Generating/Printing System (KaDiary) using Geotagged Photos and Extracting Tourists' Behavior from Diaries

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Abstract—**Understanding the needs of tourists is important for many areas of tourism. Travel diaries, which include geotagged photos, are becoming popular tools to collect and analyze tourist behavior. We developed a travel diary generating/printing system called KaDiary, which can generate a digital travel diary from geotagged photos taken by tourists, and print the digital travel diary using a printer. This paper describes the development of the KaDiary, the effectiveness of the system and the experiments, which extract tourist behavior from travel diaries on Shodo Island. Results of the experiments identified attractive tourist spots, travel times, including the start times and end times of travel, as well as identified popular travel routes on the island.**

Keywords–Travel diary; Extract tourists' behavior; Geotagged photo.

I. INTRODUCTION

Recalling and sharing travel experiences is an important factor for tourism and can inspire tourists to revisit previous locations or invite new tourists to visit travel spots. Collecting and analyzing tourist behavior using geotagged photos has recently attracted a lot of attention and is important to understanding the needs of tourists. By counting the number of photos taken in tourist spots and plotting them to a map using geographical information, we can identify tourist behaviors and easily distinguish which tourist spots are attractive. Of course we can discover the interests of tourists by simply looking at the photos, however, a travel diary using geotagged photos has more advantages because it focuses on the information of tourists as well as the photos. To utilize this information, we developed a travel diary generating/printing system called the KaDiary. The KaDiary generates digital travel diaries (Web-formatted or PDF-formatted) using photos taken by tourists and comments that are given to photos, and prints the digital travel diary using a printer. The travel diary consists of photos, comments, travel behaviors including when and where the tourists visited, the order of tourism spots visited by tourists and the time spent on tourism. Photos and comments are selected using mobile devices by tourists. Travel behaviors are extracted from Exchangeable Image File Formats (EXIF), which are applied to photos. There are many benefits from

using our system: (1) Tourists can look back on their experience using a printed travel diary. (2) Tourists can share the digital travel diary with other tourists via the Internet and social media. (3) We can obtain valuable information regarding travel behaviors. This paper describes the development of the KaDiary and confirms the system's effectiveness through experiments conducted to extract tourist behavior on Shodo Island. From the travel diaries we were able to identify the most attractive tourist spots, tourists' travel time, start time of travel, end time of travel and the most popular travel routes on Shodo Island.

This paper is organized as follows. Section II describes related work. Section III describes the development of the KaDiary. Section IV describes the experiment design. Section V describes the result of the analysis. Section VI describes our conclusion and future works.

II. RELATED WORK

Travel behaviors have been recorded for centuries. However, with the popularization of mobile apps and the Internet, travel diaries have become valuable sources of information. Greaves et al.[1] developed and deployed an online seven day travel/activity diary and companion smartphone app to investigate changes in travel behavior and health indicators of residents before and after the construction of a major piece of cycling infrastructure. The smartphone app, which records travel routes on a map can improve both the recall of trips and the accuracy of trip reporting. Safi et al.[2] designed and implemented a smartphone-based travel survey system. Their system provides users with more convenient procedure for recalling and reporting their travel behavior. Our system not only provides a digital travel diary, but can also print travel diaries using a printer. Tourists can access the system using a general camera application and web browser available on most mobile devices without installing a special application.

With the increasing of Global Positioning System (GPS) equipped devices, such as smartphones and tablets, most of photos are having geographical information, which has led to many research projects. Vu et al.[3] explored the activities
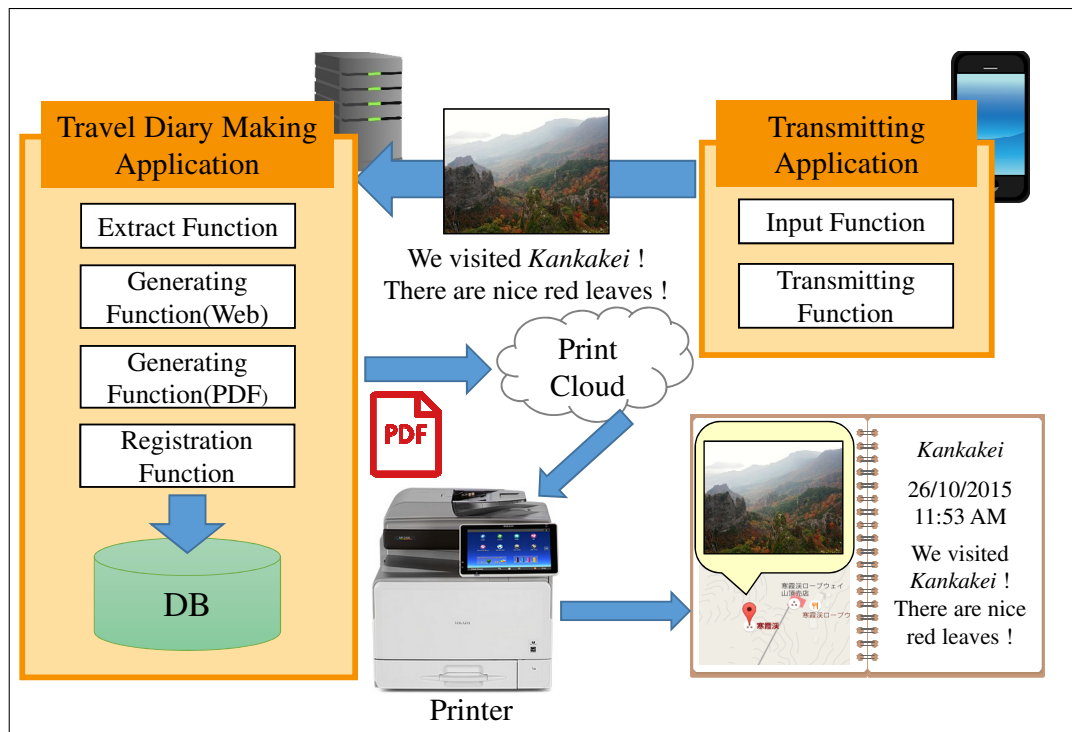
Figure 1. Overview of the Travel Diary Printing/Generating System.

of park visitors in Hong Kong using geotagged photos. They extracted photo locations and photo textual information such as user profiles, photo titles, user-defined photo tags, and content descriptions using text processing, to analyze visitor activity. Kurashima et al.[4] recommended travel route using geotagged photos. They assumed that the collection of each photographer's geotagged photos was a sequence of visited locations, and generated travel routes based on that information. Given that travel information is important for understanding tourist behavior, we tried to extract tourist activities and travel routes from geotagged photos as well.

However, contrary to existing approaches, our system does not require the installation of a special application. Tourists can make travel diaries by taking photos using a general camera application and upload them through a web browser. The system not only creates a digital travel diary, but can also print the travel diary for future recollection and generate a database for tourist behaviors.

III.   DEVELOPMENT OF THE KADIARY

This section describes the development of the KaDiary. Section A describes an overview of the system. Section B describes the workflow of the system.

A. System Overview

We developed the KaDiary as a Web application giving tourists the ability to run it on a PC or a mobile device without having to install a special application. Also, we developed the KaDiary using Microsoft Azure[5], which is Cloud Computing Platform that it can be used from any tourist spots. Figure. 1 shows an overview of the KaDiary. The KaDiary includes a transmitting application, a travel diary making application, a print cloud and a printer.

TABLE I. EXAMPLE OF EXIF INFORMATION

Information	Description
Maker	ASUS
Model	Nexus7
Date and Time	2014:08:06 10:32:45
Filename	Ritsurin1.JPEG
Latitude	34.3289
Longitude	134.0447
Thumbnail.Height	320px
Thumbnail.Width	480px
MimeType	image/jpeg

The transmitting application has an input function and a transmitting function. The input function allows the user to input a title for the travel diary and add photos and comments for each photo. In order to reduce user anxiety, titles and comments are not necessary to print a diary, however, if no title is detected, the system generates a generic title, for example, "Shodo Island Travel Diary". The transmitting function transmits the title, photos and comments to the travel diary making application.

The travel diary making application creates a digital travel diary as a Web file or a PDF file from the title, photos and comments. The application consists of an extract function, a generating function (Web and PDF) and a registration function. The extract function analyzes the exchangeable image file format (EXIF) and extracts the latitude and longitude as well as the date and time, of each photo. Table I shows an example of EXIF information. The latitude, longitude, date and time in the table can be used for extracting travel behaviors and valuable information about tourism such what are the most popular tourist spots and when's best season to visit. The Web generating function creates a Web formatted travel diary.

However, before generating a Web travel diary, the function edits photos to ensure same size printing on paper. After photo editing, the function generates a Web travel diary using latitude, longitude, date, time and Google Maps APIs[6]. Using Google Maps APIs, the function can extract the order of tourist spots visited as a travel route, and display them on a map, which is also included in the Web travel diary as long as each photo contains geographical information, otherwise the travel route will not appear. The Web travel diary can also be shared with other tourists through the Internet.

The PDF generating function creates a PDF formatted travel diary from the Web travel diary. By generating a PDF travel diary, the application can upload it to a print cloud, which is mentioned below. The registration function registers the EXIF information, comments, title, Web travel diary and the PDF travel diary to a database, which can be used analyze tourist behavior.

The PDF travel diary is registered and saved as a print job in print cloud, and tourists can print it using any printer with print cloud capabilities. Moreover, tourists can print their travel diary without installing specific printer drivers, making it possible to use their own devices.

Figure. 2, 3 and 4 show example pages of a travel diary. Figure. 2 shows an example of a cover page, which includes a map, title, travel date, travel time and travel distance. On the map, there are pins and lines. The pins, ordered in chronological order from A to G, represent locations where the photos were taken using latitude and longitude. The lines represent the travel route from pin to pin. The title is taken from the transmitting application. The travel date is extracted from the date of first photo taken at the beginning of travel. The travel time is the difference between the time of the first photo and last photo taken at the end of travel. The travel distance is automatically calculated from the travel route on the map using Google Maps APIs. Figure. 3 shows an example of a main page. It includes the travel title, travel date, travel time, photos and comments. Photos and comments are uploaded by tourists using the transmitting application. Figure. 4 shows an example of an outline page. It includes a small map, title, travel date, travel time, travel distance and photos. This page is generated based on the idea that some tourists want to see the map and photos on a sheet of paper.

B. *Workflow of the KaDiary*

The following shows the workflow of the KaDiary.

1) Input the title, photos and comments by using the input function of the transmitting application and transmit them to the travel diary making application from tourist's device.
2) Extract latitude, longitude, date and time from photos using the extract function of travel diary making application.
3) Generate a Web travel diary with a title, photos, comments, latitude, longitude, date, time and Google Maps APIs using the Web generating function.
4) Generate a PDF travel diary from the Web travel diary using the PDF generating function.
5) Register the EXIF information of photos, comments, title, Web travel diary and the travel diary to a database using the registration function.
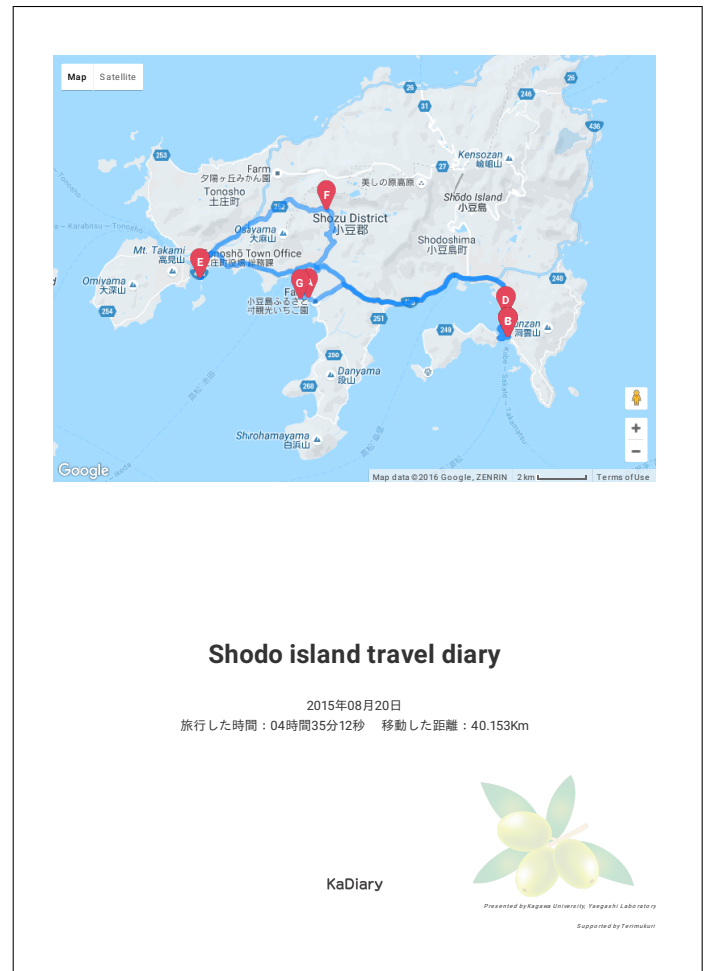

Figure 2. Example of Cover Page.

6) Upload the PDF travel diary to the print cloud.
7) Print a PDF travel diary using a printer with print cloud capabilities.

IV. EXPERIMENT DESIGN

We conducted experiments to confirm the effectiveness of the system on Shodo Island. Shodo Island is one of the many islands located in the Seto Inland sea of Japan. The number of tourists who visited Shodo Island were 1,044 in 2003[7]. We added some limitations to the KaDiary system to ensure easy and quick use of the system during peak travel times: First, we limited the number of photos to 9 as tourists often take many photos in tourist spots, and may upload plenty of photos to the system reducing the time to print a diary. Second, we limited the paper size of the diary to A4 only, in order to provide a handy travel diary for tourists. Third, we limited the number of pages to 3, in order to further reduce the time to print a diary.

Finally, we put the Printer, with print cloud capabilities, in a leisure facility. Tourists could upload the photos from anywhere using KaDiary, but could print the diary at the leisure facility only. These experiments were conducted on Oct 21, 22, 23, 29, 30, Nov 5 and 6, 2016 on Shodo Island and tourists could obtain a printed travel diary and digital travel
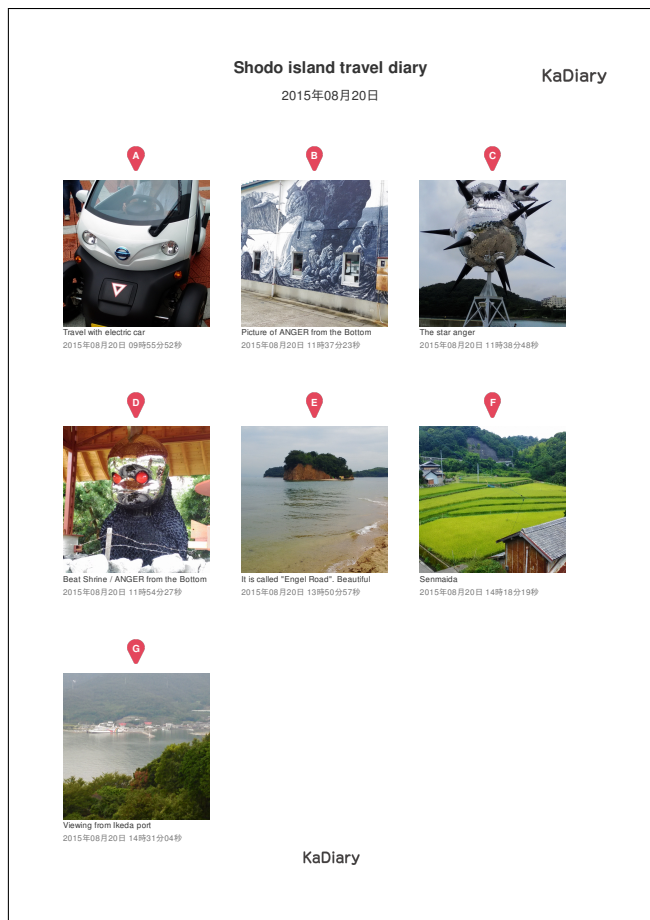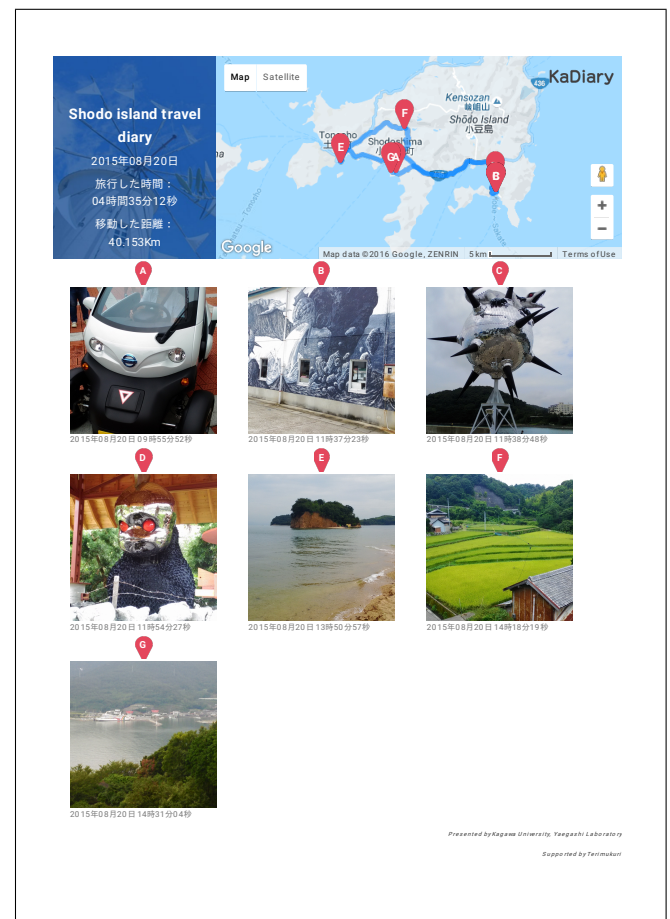
Figure 3. Example of Main Page.

Figure 4. Example of Outline Page.

diary for free. Figure. 5 shows the printer in the Shodo Island Furusatomura.

V. RESULT ANALYSIS

The experiments yielded many photos and diaries. Table II shows the number of diaries and photos, which were extracted by KaDiary. There were a total of 71 diaries of which 18 were route available and a total of 492 photos of which 207 were geotagged.

Figure. 6 shows the location of photos taken on Shodo Island. Many photos were taken in the same places and were focused in the southern part of Shodo Island, making it very useful for identifying attractive tourist spots. Figure. 7 shows the number of travels per travel time. The highest number of tourists was found between 2:00 to 5:00 hours. These results mean that tourists can travel to popular spots in one day without the need to use accommodations on the island. Figure. 8 shows the number of photos per time zone. The highest numbers of photos were taken around noon, leading us to believe that most tourists came to the island around 8:00 am and left the island around 5:00 pm. Figure. 9 shows the travel routes for Shodo Island. This map is includes all the travel routes, which appeared on the diaries. The darker lines are routes more traveled by tourists while the lighter lines are routes less traveled. This map allows us to identify popular

Figure 5. Printer in the Shodo Island Furusatomura.

TABLE II. NUMBER OF DIARIES AND PHOTOS WHICH ARE ACQUIRED BY KADIARY

Date	Diaries	Route available diaries	Ratio percentage (diaries)	Photos	Geotagged photos	Ratio percentage (photos)
21/10 Fri	3	0	0%	24	5	20.8%
22/10 Sat	8	3	37.5%	45	23	50.1%
23/10 Sun	13	3	23.1%	92	36	39.1%
29/10 Sat	9	1	11.1%	65	23	35.4%
30/10 Sut	11	2	18.2%	64	18	28.1%
5/11 Sat	9	2	22.2%	60	24	40.0%
6/11 Sun	18	7	38.9%	142	78	54.9%
Total	71	18	25.4%	492	207	42.1%
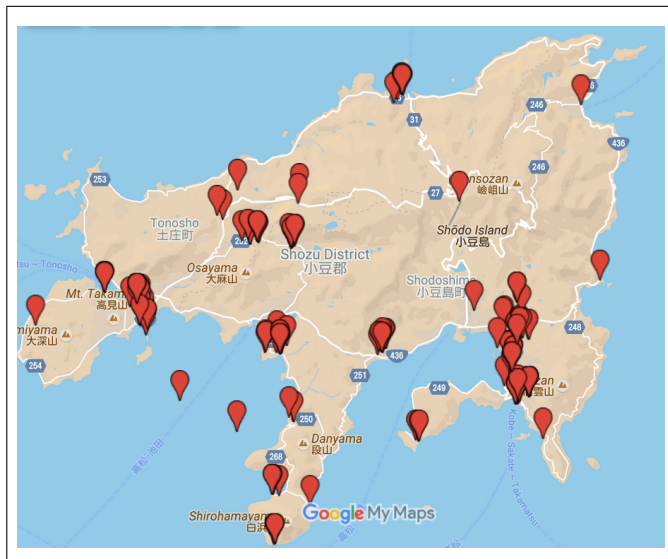
Figure 6. Location of Photos Taken on Shodo Island.

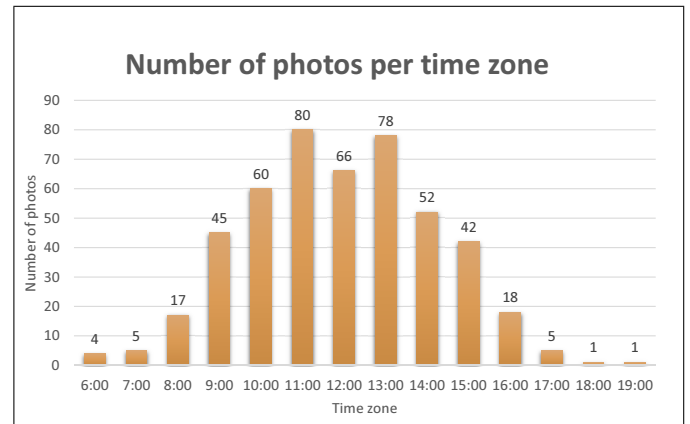Figure 8. Number of Photos per Time Zone.

Figure 7. Number of Travels per Travel Hour.

Figure 9. Travel Routes on Shodo Island.

travel routes used by tourists to visit many tourist spots in a short amount of time.

VI. CONCLUSION AND FUTURE WORKS

This paper describes the development of a travel diary generating/printing system called the KaDiary using geotagged photos. The KaDiary generates digital travel diaries (Web-formatted and PDF-formatted) using photos and comments from tourists and prints the digital travel diary using a printer. This system uses the cloud environment and thus can be used in other tourist spots. There are many benefits to using our system: (1) Tourists can look back on their experience. (2) Tourists can share their digital travel diary with other tourists. (3) We can obtain valuable information about tourism in order to learn about travel behaviors. The KaDiary has a transmitting application, a travel diary making application, a print cloud and a printer. The transmitting application runs on devices used by a tourist and can upload selected photos and input titles as well

as comments. The travel diary making application can generate digital travel diaries (Web-formatted and PDF formatted) using EXIF data and Google Maps APIs. Tourists can print their own travel diary without installing specific printer drivers using a printer with print cloud capabilities. The results of experiments conducted on Shodo Island show that we can identify attractive tourist spots, travel times, including the start times and end times of travel, as well as identify popular travel routes on the island. Comments from tourists who used the KaDiary, were very positive, for example "I am surprised about the accuracy of the travel route." and "It is nice to have a paper to look back on my travel."

In the future we are planning to implement more functions to enhance tourist satisfaction and extract more information:

1) On Shodo Island there are some indoor tourist spots where GPS signals are unavailable. Therefore, it is necessary to include a function that automatically adds geographical information to photos using image processing.

2) Tourists could not change the layout of the travel diary. Therefore it is necessary to include a function to allow tourists to change the layout of their travel diary.

3) Some tourists took a long time selecting photos. Therefore, it is necessary to include a function that can identify photos tourists want to select, and generate travel diaries automatically from identified photos.

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