Exploring Park Visitors' Activities in Hong Kong using Geotagged Photos

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Abstract Understanding tourist activities could help attraction managers for appropriate planning and decision making. For a metropolitan city with limited land as Hong Kong, insight into what tourists have done in the urban area is vitally important. Tourists' travel photos, tagged with geographical information, can assist attraction managers in identifying tourism hot spots and the activities that the visitors are interested in at certain spots. This study examined major visitor's activities in the urban parks in Hong Kong by utilizing the geotagged photos posted on the social media sites. The results indicated that visitors had different interests in different parks. Moreover, the focuses of park visitors are different between local residents and international tourists. By spotting the photo locations, attraction managers can identify the tourists' concentration so as to arrange better management on crowd control and visitors' safety.

Keywords Tourist activities • Geotagged photos • Urban parks • Hong Kong • Attractions management

1 Introduction

Photos are visual ways to represent tourists' travel experience (Albers & James, 1988) and "photographs are a common way to communicate personal trip experiences and perceived destination images" (Schmallegger, Carson, & Jacobsen, 2009, p. 245). With the wide spread to travel photos on online community and media-sharing websites such as Facebook and Flickr, tourists could able to obtain various visual information about the destinations or the attractions before they travel. Destination photography images can shape or reshape potential travelers'

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A. Inversini, R. Schegg (eds.), *Information and Communication Technologies in Tourism 2016*, DOI 10.1007/978-3-319-28231-2_14

destination perceptions and, consequently, influence their decision-making processes (Mutinda & Mayaka, 2012). Research on the relationship between destination perceptions and visitors' cultural backgrounds has been identified as an important direction for destination image studies, which aims to help *destination marketing organizations* (DMOs) for a more effective position and to promote tourism offers in culturally different target markets (Kastenholz, 2010). However, tourists always scattered around various destinations base on their specific travel interests. It is difficult to survey every tourist to collect and identify the individual activities attracted him or her most at all tourism spots. Although a big number of surveys were conducted every year, only few attraction managers from big scale tourism spots can obtain the resulting statistics; no detailed report of small scale tourism spots was available to the public. For example, the *Hong Kong Tourism Board* (HKTB) claimed that *Hong Kong Park* was one of the popular tourists' attractions with around 11 % long-haul and 4 % of overall tourists visited in 2014 (HKTB, 2014). The HKTB report only shows the tourist profile distribution, without any information about the tourism activities in the park. *Hong Kong Park* was the only park reported in the survey, however there are two more city parks, *Kowloon Park* and *Victoria Park*, were listed on HKTB website (http://www.discoverhongkong.com/ca/see-do/great-outdoors/city-parks/index.jsp). With limited description provided, the tourists visiting and activity information are still remained unclear. In order to fill this gap, a project *aimed to uncover the visitors' distribution and the attractive activities in popular tourism spots in Hong Kong* was conducted.

Recently the availability of socially generated and user-contributed geotagged photos on the Internet has presented a new way to capture and analyze tourists' behaviors at the destinations (Vu, Li, Law, & Yip, 2015). Those geotagged photos were taken along the tourists' travelling path using digital photos capturing devices such as smartphones and tablets. Such digital devices are equipped with a built-in *global positioning system* (GPS) to automatically record geographical information. When the tourists posted their travel photos to online social media sites, the geographical information were uploaded together as the Metadata that can be retrieved later. The scholars and the managers will be able to infer tourists' movement trajectories by tracking the locations where they took the photos (Vu et al., 2015). However, the geotagged photos have unpredictable value, which have been explored much yet. This paper attempted to explore the visitors' activities in popular parks in Hong Kong using geotagged photos and the Metadata attached. The outcomes were expected to provide valuable information to the attraction managers of the small scale tourism spots in Hong Kong for business planning, marketing strategies, and attraction management.

Having thus set the context for undertaking this work, the rest of the paper is organized as follows: Sect. 2 reviews existing works in studying tourist activities; Sect. 3 presents the methods for extracting and processing geotagged data; a case study of analyzing the activities in popular parks in Hong Kong and the corresponding findings are reported in Sect. 4; Sect. 5 concludes the paper with practical implication and future research direction.

2 Literature Review

Tourist destination has been intensively researched for years. Most of the works focused on understanding visitors' perception and destination choice (Syed-Ahmad, Musa, Klobas, & Murphy, 2013). Various factors have been reported to have effects on tourists' destination choices, including travel motivation and satisfaction (Yoon & Uysal, 2005), prices and distance (Nicolau & Más, 2006), culture and historical resources, and environmental safety (Hsu, Tsai, & Wu, 2009). Besides, tourist's interest in the activities available at the destinations is another factor that takes an important role in decision-making process (Deutsch-Burgner, Ravualaparthy, & Goulias, 2014). Destination marketing performance can be thus enhanced by activities segmentation (Mumuni & Mansour, 2014). Based on the tourists preferred vacation activities and their preferences, tourists can be grouped into different segments so that destination marketers could have a better focus when they conduct marketing campaigns.

As part of the daily tasks, attraction managers need to manage and elevate profitability as well as deal with various technical issues including crowd control, health and safety, and consumer satisfaction (Tribe, 2008). With the wide spread of user generated content on the Internet, scholars and managers can easily obtain a large amount of data that contain the visitors' profiles, textual and visual information about tourists' past travel experience from various social media sites. Textual comments have become a major source of customer behavioral and satisfactory studies in the past decade (Schuckert, Liu, & Law, 2015). On the other hand, more and more researchers put their eyes on the photo images taken and posted by tourists to share experience and express opinions on their past travels (Ding, Liu, & Zhang, 2009; Ye, Zhang, & Law, 2009). Recently, geotagged photos attracted much attention on analyzing tourists' travel pattern (Hsu et al., 2009), suggesting travel routes (Kurashima, Iwata, Irie, & Fujimura, 2012), providing personalized travel recommendations from demographics of individuals, and grouping travelers of and their travel paths (Chen, Cheng, & Hsu, 2013). Despite the effort was made, majority of existing studies focused on tourists' travel pattern or routes but not focused on what they have done at the tourism spots.

Furthermore, many spots such as parks were not designed just for international tourists, but also for local residents. These two groups of visitors may have different motivations of their visits and other expectations on the activities available. In order to satisfy all potential visitors, attraction managers need to have a good understanding of the behaviors and preference of both local residents and international travelers. However, this is still an open topic waiting for researchers and managers to explore further. Aiming to bridge the gap in understanding the activities of park visitors, this study utilized the geotagged photos to identify the most popular parks in Hong Kong and revealed tourists activities at those parks. The differences in the interested activities between international and local visitors were marked as well. The next section presents the details of the methodology used in this work.

3 Methodology

The geotagged photo data were firstly extracted from Flickr using its Application Programming Interface (API, www.flickr.com/services/api). The region can be specified by a bounding box with four coordinates x_{min}, y_{min}, x_{max} and y_{max} that indicate minimum longitude, minimum latitude, maximum longitude, and maximum latitude, respectively. A keyword was used to narrow down the search space to return only the relevant geotagged photos. For example, the keyword "*park*" was used in data collection to obtain all the photos taken in the parks. Then a clustering technique, named P-DBSCAN (Kisilevich, Mansmann, & Keim, 2010) was adopted to identify the most popular parks based on both the number of the visitors and the posted photos.

Two steps were involved in the proposed analysis model: (1) geotagged photo clustering, and (2) textual Metadata processing. With the purpose of obtaining objective result, a clustering technique was adopted to automatically identify the popular parks that had attracted most visitors and the number of the photos they took and posted on the social media sites. The Metadata attached to the uploaded photos contains textual information, such as user profiles, photo titles, user-defined photo tags, and content descriptions, which often reflects the motivation of the photo taking. Such textual data need to be processed before the analysis can be carried out. Text-processing technique applied on the Metadata can help to discover the park visitors' interests and infer the activities they would like to participate.

3.1 Geotagged Photo Clustering

Suppose D is a collection of geotagged photos, a photo p is referenced by a value pairs $<x_p, y_p>$ for longitude and latitude respectively. Distance between two photos p and q is defined as $Dis\ (p,q)$. The neighborhood photo $N_\theta(p)$ of a photo p is defined by:

$$N_\theta(p) = \left(q \in D, Owner(q) \neq Owner(p) \;\middle|\; Dist(p,q) \leq \theta\right) \tag{1}$$

where θ is a neighborhood radius, $Owner(q)$ is an ownership function to specify the owner of photo q. If photo q is not owned by the same user as photo p and its location is within the neighborhood radius θ, photo q is called the neighbor of photo p. Let $NeighborOwner(p)$ be the owner number of the neighbor photos $N_\theta(p)$, and δ be the threshold, photo p can be called as a *core photo* if $NeighborOwner(p) \geq \delta$. The values θ and δ are pre-determined based on the scales of the specific applications. If the region to be identified is at the macro level, large values can be assigned to θ and δ, otherwise, smaller values can be used instead. By considering the ownership, the clustering process can account for the actual number of visitors

rather than only by the photos. Thus, the identified clusters indicate locations with many visitors.

At the beginning of the clustering process, all photos are marked as unprocessed. For each photo p_i, if it is not a core photo, then it is marked as irrelevant and is discarded. Otherwise, it is assigned to a cluster c, and all of its neighbors are put into a queue to be processed next. Each of the neighboring photos is processed and assigned to the current cluster c until the queue is empty. The process iterates for the rest of the unprocessed photo in the data set, and results a set of clusters C. The geographical coordinates are then translated to present the name and the spatial extent of the area.

3.2 Textual Meta-Data Processing

The textual information stored in the Metadata can help to identify the tourists' interests and the activities they participated. If a tourist took photos of certain things or objects that they were interested in or want to record in memory, they would often put specific keywords as photo tags or left short notes in photo descriptions. Such textural data are normally unstructured, which are not easy to be analyzed directly. To solve this problem, a powerful text processing tool called *General Architect for Text Engineering* (GATE) (http://gate.ac.uk/) was employed. GATE supports English lexicon to provide a comprehensive list of vocabulary terms to describe the interests.

Suppose a photo data set P, in which each photo p_i contains the Metadata of its title, tags, and description and denoted as t_i. The Metadata t_i of each photo p_i is a string of text, which is firstly loaded into a text tokenizing algorithm. The textual stream is broken into words, phrases, symbols, or other meaningful elements called "tokens". The tokens are then passed through a filter to normalize all letters to lower case, where symbols or numbers are removed. The remaining tokens were input into a stemming process to reduce inflected words to their stem, base, or root form. For instance, the words "*trees*" and "*flowers*" reduced to "*tree*" and "*flower*". The stemmed token list for each photo is denoted as $S^{(i)} = \left\{ s_1^{(i)}, s_2^{(i)}, \ldots \right\}$. It is assumed that the English vocabulary of noun types is used to refer to entities, such as tourist interests (e.g., *tree*, *flower*). Therefore, a list of stemmed nouns appeared in the data set is constructed as $N = \{n_1, n_2, \ldots, n_m\}$. The word types, such as *noun*, *verb*, or *adjective* are determined based on a set of tags for each word in the English lexicon of Gate.

Once the word list is ready, we move to identify a set of the interesting nouns from the list for further analysis as potential visitor interest. Specifically, a binary vector $\left\{ v^{(i)} = v_1^{(i)}, v_2^{(i)}, \ \ldots v_m^{(i)} \right\}$ was constructed for each visitor, where $v_j^{(i)}$ takes the value of 1 if n_j appear at least once in the textual Metadata of the photo

collection belonging to user u_i; or 0 otherwise. The degree of interest of each noun, $n_j \in N$, is evaluated by a support value:

$$supp(n_j) = \frac{count(n_j)}{|U|} \tag{2}$$

where $count(n_j)$ is the count of vector $\boldsymbol{v}^{(i)}$, whose value $v_j^{(i)} = 1$, and $|U|$ is the total number of visitors in the collected data set. A user predefined support threshold β is used to measure the significance of the nouns. If a noun n_j satisfies $supp(n_j) \geq \beta$, then n_j is selected into the visitor interest candidate list; otherwise it is discarded. By this way, we do not need to provide a set of predefined keywords; instead a list of candidates is automatically constructed from the textual Metadata. The support threshold β is set to eliminate infrequent nouns, while retaining potentially interesting one for subsequent analysis. Once the visitor interests are identified, we can exam the actual photos taken for each individual interest to have insight into tourists' own travel experience.

4 Experiment Design and Result Analysis

Following the methodology presented in the previous section, we implemented the proposed model using a geotagged photo data set collected from Flickr to explore the park visitors' interests and the activities they participated in Hong Kong area.

4.1 Popular Park Identification and Data Extraction

In order to identify the popular parks, we extract all photos with the tag "*park*" over geographical area of Hong Kong. A bounding box was defined with the parameters ($x_{min} = 113.887603$; $y_{min} = 22.215377$; $x_{max} = 114.360015$; $y_{max} = 22.51446$) to cover the entire area shown in Fig. 1. The combination of bounding box parameters and "park" tag help to narrow the search to photos relevant to park and taken in Hong Kong area. The photos were collected in a time period of recent five and half years, from 1st January 2010 to 30th June 2015. The extraction process result *6457* photos collected from *792* users.

The P-DBSCAN clustering technique was applied to the collected data set for the popular parks with most visitors and photos taken. The neighborhood radius value was set as $\theta = 0.002$, which is equivalent to approximately 150 m. This small sale is suitable for identifying the location of interest at a micro level such as parks. The minimum owner number δ was set as *10 %* of the total number of users. The returned clusters were automatically determined based on the density of the photo points and visitor numbers without any manual control. Figure 2 shows the

Fig. 1 Locations of park photos

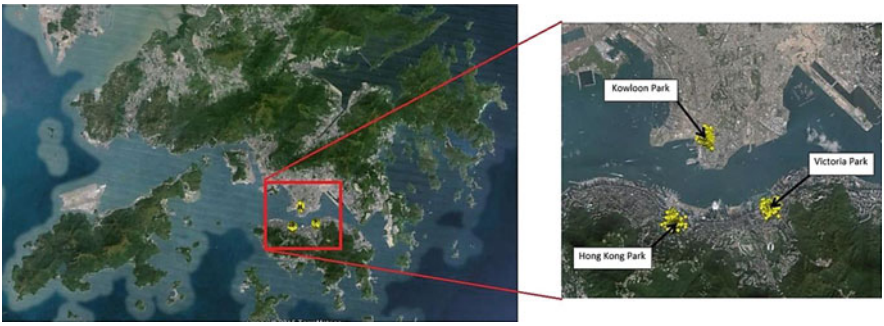


Fig. 2 Popular parks identified in clustering process

result with a zoom in closer to three individual clusters: *Kowloon Park, Hong Kong Park* and *Victoria Park*. Such result confirmed the popular parks announced on the HKTB website.

By considering the factor that some photos taken inside the park may not be tagged with the "*park*" tag, we performed a second round of data collection to focus on the photos that were taken inside these three parks. Since, the geographical areas of the parks are not always rectangular, therefore multiple bounding boxes were defined complementary to each other to cover the areas as much as possible. As a result, we obtained much more geotagged photos that were taken inside the parks rather than only considering to have those with keyword "*park*" in Metadata. A statistic summary of the collected new data set is presented in Table 1. Different from the existing understanding, *Victoria Park* attracted more visitors than other two parks in the past 5 years.

Table 1 Park visitors data sets

Location	Visitors	Photos	Photo numbers per visitor
Victoria Park	462	9094	19.68
Hong Kong Park	382	3082	8.07
Kowloon Park	382	1975	5.17

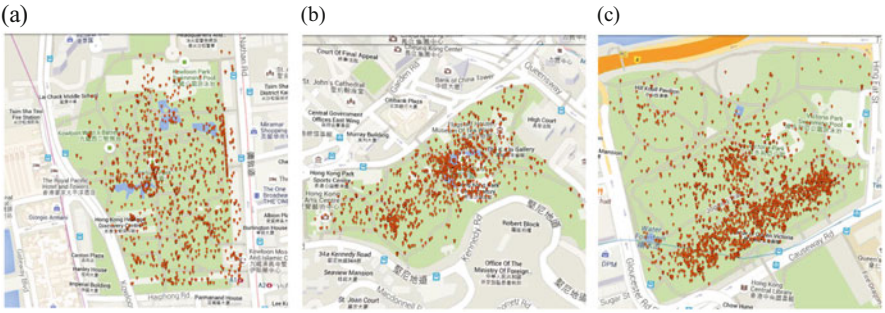


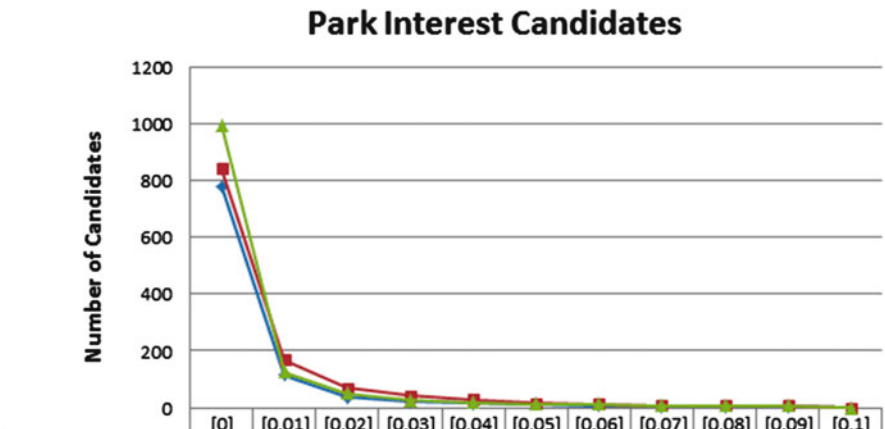
Fig. 3 Location of photos taken inside the parks (**a**) Kowloon Park, (**b**) Hong Kong Park, (**c**) Victoria Park

Figure 3 shows the exact location of each photo in the parks, denoted as a dot on the map. Visitors in *Kowloon Park* tended to spread over the entire park area; *Hong Kong Park* attracted more visitors to take photos near the central lake; while in *Victoria Park*, visitors preferred more to stay in the southern area.

4.2 Visitor Interest Analysis

To identify the popular interests of visitors in the parks, we adopted the text processing technique on the textual Metadata attached to the collected photo data set. To obtain an objective result, we did not use a predefined value for the support threshold β, but examined a range of values (from *0* to *0.1*) on the collected data set to pick an appropriate one that suited this park case study the best. In Fig. 4, the numbers of interest candidates drop dramatically as the β increase from *0* to *0.02*, and then decreased gradually. When $\beta = 0$, the algorithm returns all the nouns in the stemmed noun list for each park; when $\beta = 0.1$, no interest candidate is returned for any park.

In this study, we aimed to explore only the most popular interests of visitors, therefore a support threshold β was set to *0.05*, which returned a reasonable number of the candidates: 15 for *Kowloon Park*, 14 for *Hong Kong Park*, and 11 for *Victoria Park* respectively. With this relatively small number of interest candidates, it is possible for the attraction managers to explore further with the corresponding photos for more information. We inspected the candidate lists to identify the top



	[0]	[0.01]	[0.02]	[0.03]	[0.04]	[0.05]	[0.06]	[0.07]	[0.08]	[0.09]	[0.1]
Kowloon Park	780	115	36	21	14	11	7	5	5	4	0
Hong Kong Park	840	168	68	41	28	14	11	7	6	6	0
Victoria Park	995	126	51	25	18	13	13	7	7	7	0

Fig. 4 Candidates of visitors' interests against various support threshold values

interests that the visitors recorded by their photos. Table 2 lists the top four candidates and their corresponding support values for each park. The higher the support value is the more visitors have participated in with photos. Both "*birds*" and "*flowers*" appeared frequently in all three lists, but the *Kowloon Park* is highlighted by the interest of "*bird*"; while "*flamingo*" is the name of a special spice of birds. This proved Pan, Lee and Tsai's conclusion (2014) that natural resources were the key elements in tourism development and were mainly associated with pleasant feelings visitors developed for a destination. On the other hand, "*tower*" and "*skyscraper*" photos were taken quite often in *Hong Kong Park*, while, more photos of "*people*" and "*festival*" were taken in *Victoria Park*.

Moreover, with the top interest list, we could check the actual photo content to see how visitors perceive the image of a destination. Thus, visual inspection of the photos was carried out for the photos belong to each of the interests. As the result, we found a common pattern that most of the "*flower*" photos were taken within a close distance to focus on the details in all three parks (see Fig. 5). Similar cases were captured for "*birds*" in *Kowloon Park* and *Hong Kong Park* (see Fig. 6). The visitors also recorded the special behaviors for flamingos that always stayed and flew in groups; while the other spices of birds can be captured alone. In *Hong Kong Park*, the "*tower*" and "*skyscraper*" photos were normally taken in daytime; however, the "*people*" and "*festival*" photos in *Victoria Park* contained more evening events (Fig. 7b). Interestingly, the "*tree*" tagged photos taken in *Kowloon Park* normally focused on other objects (for example, buildings as shown in Fig. 8) rather than trees. Due to privacy issue, no photo with any content that can be used to identify individual visitor is shown in this paper.

Table 2 Identified interests of park visitors

Victoria Park		Hong Kong Park		Kowloon Park	
Interest	Support	Interest	Support	Interest	Support
Flower	0.186	Bird	0.139	Tree	0.063
Show	0.117	Tower	0.068	Flower	0.060
People	0.069	Flower	0.068	Bird	0.055
Festival	0.061	Skyscraper	0.050	Flamingo	0.052

Fig. 5 Flower photos (**a**) Victoria Park, (**b**) Hong Kong Park, (**c**) Kowloon Park

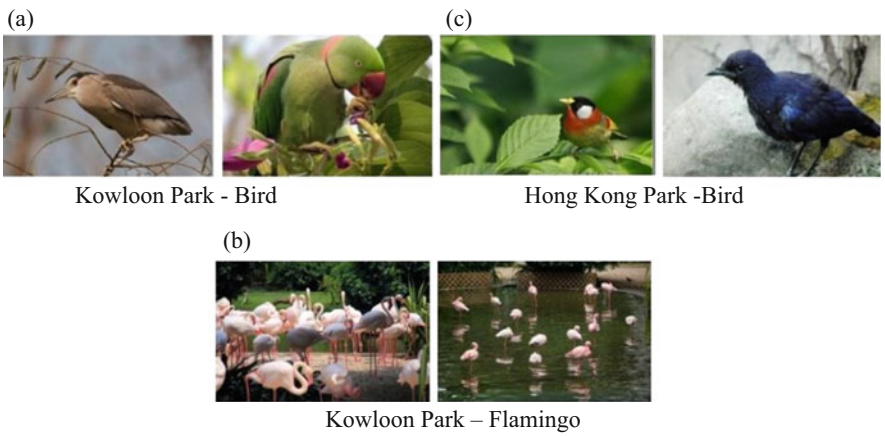


Fig. 6 Bird and flamingo photos (**a**) Kowloon Park—Bird, (**b**) Kowloon Park—Flamingo, (**c**) Hong Kong Park—Bird

Fig. 7 Photos with similar scenes (**a**) Hong Kong Park—tower and skyscraper, (**b**) Victoria Park—people and festival

Fig. 8 Photos having the "tree" tag in Kowloon Park

4.3 Contrast Analysis of Local and International Visitors

As parks in Hong Kong are opened to welcome all visitors, not only for international tourists but also the local residents, we applied a contrast analysis to explore the different interests they may have respectively. To identify the group of visitors, we queried Flickr for the location of origin for all the users in our data set (Table 2). Since the location of origin is not a mandatory criterion for Flickr registration, many users have not yet provided such information. Therefore, this study only kept the data instances with user location information available. Except the Hong Kong *local* residents, all the visitors from other countries were put into the *international* group. Table 3 shows the statistics of *local* and *international* visitors for all three parks. Notably, the exclusion of visitors without location information left us with less data than in the previous analysis. However, it should still be sufficient for our aim of contrasting the difference between the groups. As the photos with tags of "*tower*" and "*skyscraper*" shared similar objects, we merged them into one single interest item as "*building*". We also merged the photos of "*people*" with those tagged as "*festival*" for the same reason. The "*Tree*" photos at *Kowloon Park* actually had random objects, thus we excluded them from this analysis.

Table 3 Local and international visitor data sets statistics

	Local		International	
Location	No. of visitors	No. of photos	No. of visitors	No. of photos
Victoria Park	135	3603	78	1023
Kowloon Park	60	529	110	545
Hong Kong Park	57	859	103	559

Table 4 Chi-square test on park interests between local and international visitors

Location	Interest	Local visitor (%)	International visitor (%)	Difference	χ^2	*p*-Value
Victoria Park	Flower	29.63	15.38	14.25	5.4363	0.020*
	Festival	14.07	16.67	−2.60	0.2603	0.610
Kowloon Park	Flower	18.33	4.55	13.78	8.6566	0.003*
	Bird	3.33	5.45	7.88	3.1890	0.074
	Flamingo	5.00	7.27	−2.27	0.3314	0.565
Hong Kong Park	Flower	15.79	4.85	10.94	5.4954	0.020*
	Bird	24.56	19.42	5.14	0.5802	0.446
	Building	1.75	20.39	−18.64	10.7434	0.001*

*Significance at $p < 0.05$

Proportional analysis was performed on both *local* and *interactional* visitor groups as shown in Table 4. A chi-squared statistical test with significant level of less than *0.05* was applied to verify the difference. The *local* visitors appeared to be more interested in "*flower*" than the *international* visitors in all three parks, as shown with the differences of more than *10* percentage point and *p-value* less than *0.05*. In contrast, the *international* visitors were more interested in tall "*building*" than the *local* visitors in *Hong Kong Park* (over *18* percentage point difference). Although, there were some differences between the two groups on "*bird*", "*flamingo*" and "*festival*", but not statistically significant so far.

5 Discussion and Conclusion

This study attempted to examine the visitors' activities and interests at Hong Kong's park using geotagged photos. By plotting the locations of photo taken, attraction managers are able to identify the most popular spots where visitors gathered so as to maintain a better crowd control. The southern part of *Victoria Park* and the central part of *Hong Kong Park* attracted many visitors taking photos; while the visitors scattered around *Kowloon Park* without any specific spots. Besides, this study also identified the popular tourists' interests. In the *Victoria Park*, majority visitors enjoy the festival events there; In the *Hong Kong Park*, the visitors preferred to take photos of the entire skyscrapers located in city central and

also watch birds inside the park; in the *Kowloon Park*, the visitors took a large number of photos of the flamingo birds and other natural creations. All these findings can help attraction managers to design new marketing strategies to attract tourists according to the top interests and activities in that area. They can study the different interests between the local residents and the international tourists as well. Future work will focus on analyzing the content of the photos taken in further details. For example, from all the "*festival*" photos, we will try to identify the particular events or activities that will attract more visitors than the others. Contrast analysis of visitor behavior can also be performed according to time such as days, season, and special events.

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