Using Geotagged Resources on Social Media for Cultural Tourism: A Case Study on Cultural Heritage Tourism

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Abstract. In recently, the smart tourism applications are raising the scale of data to an unprecedented level. A new emerging trend in social media namely to collect and introduce cultural heritage by geotagged resources were being focused on. The paper aims to deliver a way to collect geotagged cultural heritage resources from social networking services by using the keyword and user's position (GPS signal) to deliver smart interactions between visitors in a smart tourism environments. A large number of the cultural heritage information repositories are explored by using the user's geo-location. Therefore, from determining a user's position and context, the data that are related to cultural heritages nearby that location is collected such as photos, tags, comments. In the next step, the system is implemented for classifying and filtering the collected data belongs to users interest (e.g., the ancient capital, citadel, dynasty, tomb); determining the representative photo and important tags of each place; recommending the famous places based on photo distribution and users criteria to tourists. The experimental results show the map based on criteria given by users that contained useful information to visit some cultural heritages mentioned.

Keywords: Smart cultural tourism · Cultural heritage · Social media data · Geotags resources

1 Introduction

Nowadays, the users can exchange information easily based on the social networking services [1, 2]. Additionally, there is more and more sharing information associated with geographic locations [3]. Smart tourism applications are used popularity in recently [4–6] in which people is equipped with mobile devices can interact with cultural objects, sharing and producing data. Furthermore, they can also require useful personalized services to enhance the quality of their cultural experience [7].

In this paper, a large number of general and cultural heritage information repositories are explored based on the user's position. Therefore, from determining a user's

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position and context, the data that are related to cultural heritages nearby that location is collected such as photos, tags, comments. The application is implemented based on geotagged resources from social network services including Flickr and Instagram. It analyzes these resources to introduce to people as a smart way for guidance them during their trip.

This research aims to present a new emerging trend in social media namely introducing and collecting cultural heritage based on geotagged resources. Herein, we introduce a smart cultural tourism (SCT) system by using geotagged resources on social networking services. SCT is used to collect and analyze geotagged data from different resources on social media by using the keyword and user's position to deliver smart interactions between visitors in a smart tourism environments.

The paper is organized as follows. Section 2 refers to some studies related to smart cultural tourism and cultural tourism heritage by using resources on social networking services. In Sect. 3, we state the problem and describe some basic knowledge related to the smart tourism and location-aware based on geotagged cultural heritage resources. For the Sect. 4, we introduce the methodology for exploiting the smart cultural tourism based on geotagged cultural heritage on social networking services. Section 5 shows the experimental results that was conducted to evaluate the proposed method. Section 6 draws some conclusion and states the future works.

2 Related Works

There are many studies using social networking services as a tool to develop their tourism to introduce and to exhibit the cultural heritage to tourism in recently [7–11]. A smart context-aware system to model the context evolution, adopting a graph structure is presented by the authors [7], named Context Evolution System. The authors have showed an example of context evolution modeling inside an art exhibition named The Beauty or The Truth, located in Naples within the monumental complex of San Domenico Maggiore, Italy.

The authors in [8] have presented a platform that used social media as a data source to support the decisions of policymakers in the context of smart tourism destinations initiatives. Besides, they have showed that it is possible to identify the nationality, language of the posts, points of agglomeration and concentration of visitors based on analyzing 7.5 million tweets. Their results can be applicable to the effective management of smart tourism destinations.

Through network analysis, the authors [9] investigated utilization of Facebook by local Korean governments for developing the tourism services. They also indicated that Korean local governments Facebook pages are related to the Facebook system as part of a smart tourism ecosystem.

Besides that a framework of summarizing tourism information in response to popular tourist locations were introduced by the authors [10]. They have crawled the huge travel blog data and applied for a frequent pattern mining method in order to detect efficient travel routes in the identified popular locations. Moreover, the system had also provided a travel information to a Chinese online tourism service company.

In one of other research, the authors [11] introduce their recommendation systems and adaptive systems. The system have been introduced in travel applications to support the travelers in the decision-making processes.

In this research, we focus on exploiting a large number of geographic tags of cultural heritage resources and incorporating with media data to find a set of attractive photos and useful tags to provide and introduce to tourists some useful information related to their trip.

3 Problem Definition

3.1 Problem

To provide some useful information to tourists, the research problem is defined by two questions as follows. Does the smart cultural tourism actively use geotagged resources to provide tourism information to users for developing tourism? How might the smart cultural tourism be exploited by using social media such as Flickr, Instagram, Face-Book to open cultural heritage tourism widely?

3.2 System Overview

The workflow of SCT is showed in Fig. 1. Its components are described as follows.

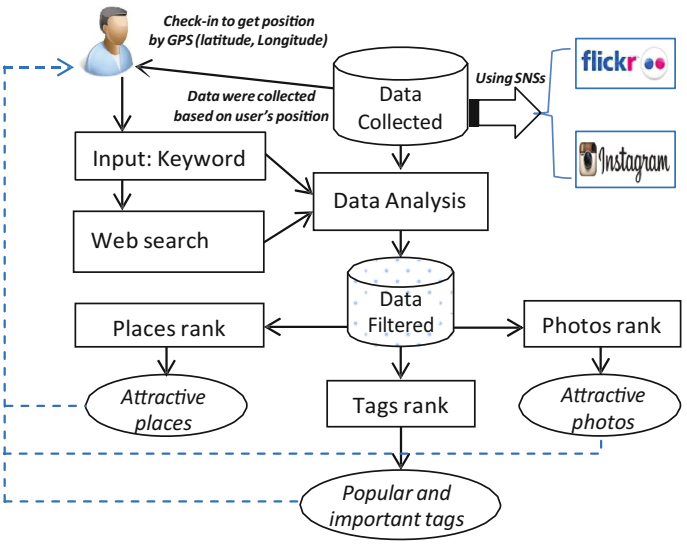

Fig. 1. The workflow of proposed model

SCT aims to uncover the areas and challenges in the execution of smart tourism systems based on geotagged resources from social media for cultural heritage tourism.

In particular, this study will unveil the four key components, principally, 'collecting data related to heritage', 'analyzing data', 'processing data', and 'showing information'.

In order to answer the research questions, we proposed some steps to implement the system for smart cultural tourism by using geotagged resources as follows:

Step 1. *Collect data based on the position of user;*
Step 2. *Filter the collected data belongs to users interest (cultural heritage);*
Step 3. *Determine the representative photo and important tags of each place;*
Step 4. *Recommend the famous places based on photo distribution and users criteria to visit;*
Step 5. *Show the map based on criteria given*

4 Solution

4.1 Computation Distribution of Resources

In order to determine the distance between position of photos, our system had used Haversine formula [12]. It is quite popular and frequently used formula when developing a Geographic Information System application or analyzing path and fields. For any two points on a sphere, the Haversine of central angle between them is given by

$$\mathcal{H}\left(\frac{d}{r}\right) = \mathcal{H}(\varphi_2 - \varphi_1) + \cos(\varphi_1)\cos(\varphi_2)\mathcal{H}(\lambda_2 - \lambda_1) \tag{1}$$

where $\mathcal{H}$ is the haversine function $\mathcal{H}(\theta) = \sin^2\left(\frac{\theta}{2}\right) = \frac{1-\cos(\theta)}{2}$

d is the distance between the two points (along a great circle of the sphere; see spherical distance); r is the radius of the sphere; φ_1, φ_2: latitude of point 1 and latitude of point 2, in radians; λ_1, λ_2: longitude of point 1 and longitude of point 2, in radians.

On the left side of Eq. 1, $\frac{d}{r}$ is the central angle, assuming angles are measured in radians (note that φ and λ; can be converted from radians to degrees by multiplying by $\frac{180}{pi}$ as usual).

Solve for d by applying the inverse haversine (if available) or by using the arcsine (inverse sine) function:

$$d = r\mathcal{H}^{-1}(h) = 2r\ \arcsin(\sqrt{h}) \tag{2}$$

where h is $\mathcal{H}\left(\frac{d}{r}\right)$, or more explicitly:

$$\begin{aligned} d &= 2r\ \arcsin\left(\sqrt{\mathcal{H}(\varphi_2 - \varphi_1) + \cos(\varphi_1)\cos(\varphi_2)\mathcal{H}(\lambda_2 - \lambda_1)}\right) \\ &= 2r\ \arcsin\left(\sqrt{\sin^2\left(\frac{\varphi_2 - \varphi_1}{2}\right) + \cos(\varphi_1)\cos(\varphi_2)\sin^2\left(\frac{\lambda_2 - \lambda_1}{2}\right)}\right) \end{aligned}$$

4.2 Proposed Algorithm

In this section, the distance measure between any two points to cluster photos on the dataset is used. We consider using photos such as a point on the map. They will be clustered based on its position through the distance between points which are described by latitude and longitude and a threshold.

Algorithm 1 Photos clustering

```
1: Input: a set of photo x_i ∈ P, n = |P|, x_i contains lat, lon;
2: Output: a set of photo x_i ∈ P clustered;
3: procedure Cluster(P)
4:     c ⇐ 1 // the number of cluster;
5:     Cluster(x_1) ← c;
6:     for i ∈ [2, ..., n] do;
7:         dmin ⇐ r // the radius of the sphere;
8:         for j ∈ [1, ..., i − 1] do;
9:             dist ← Distance(x_i, x_j);
10:            if dist < dmin then
11:                dmin = dist;
12:                Cluster of x_i ← Cluster of x_j;
13:            end if;
14:        end for;
15:        if dmin > threshold then
16:            c ⇐ c + 1;
17:            Cluster of x_i ← c;
18:        end if;
19:    end for;
20:    Return P; 21:
end procedure;
```

Additionally, the system used a filtered algorithm based on the similarity between the features of each visiting places and the set of photo's tags in order to remove some photos which are not close to the places corresponding to the clusters. Finally, we had applied the ranking algorithm in [13] with the data filtered by some conditions to show the results.

5 Experiment

5.1 Dataset

The system works base on the user's position to collect data from social networking services. Therefore, to implement with real-world data, we assume that users visit some places around the cultural heritage such as Hue, Hoi An, and My Son in Vietnam. Using the position of these places, the application automatically collected a set of geotagged photos from Flickr and Instagram, the dataset is described in Table 1.

Table 1. Dataset

Cultural heritage	Position	Radius	#Photos	Country
The ancient capital of Hue	16.46, 107.57	10	23557	Vietnam
Hoi An ancient town	15.88, 108.336	10	26144	Vietnam
My Son sanctuary	15.79, 108.107	2	1966	Vietnam

5.2 Experimental Results

Firstly, we collect data from user's position and then get another data based on a keyword that is given by the user. Both of two datasets are used to extract the features of each place. Secondly, the system was implemented to cluster the data to find some interested places and also select the useful tags and attractive photos to represent these places.

The Fig. 2 showed some important tags which are selected based on two factors, tags collecting from geotagged cultural heritage resources from Hue[1] and websites related to the cultural heritage mentioned by keyword given. We had combined them thanks to term frequency of tags and simulate by using TagCrowd[2] application.

Figure 3 introduces the distribution of photo before and after filtering data. Figure 4 shows some attractive photos belong to each places after the user giving some keywords including "heritage, citadel".

Fig. 2. Tags from the cultural heritages in Hue

[1] A city of the central in Vietnam.

[2] http://tagcrowd.com.

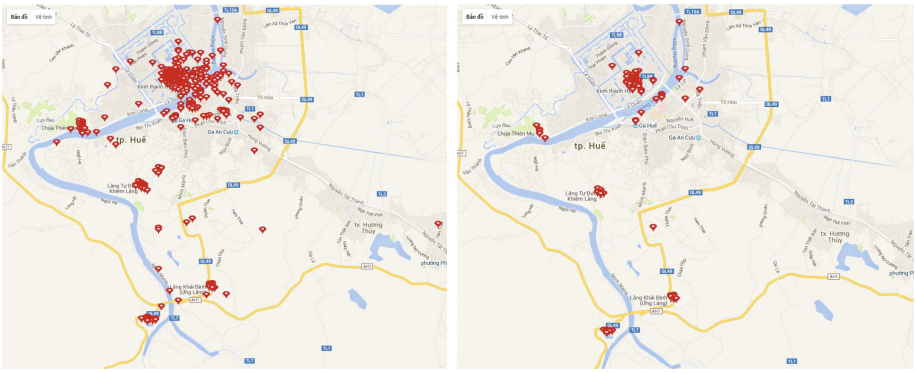

Fig. 3. Map distribution of photo based on user's position (Before and After filtering)

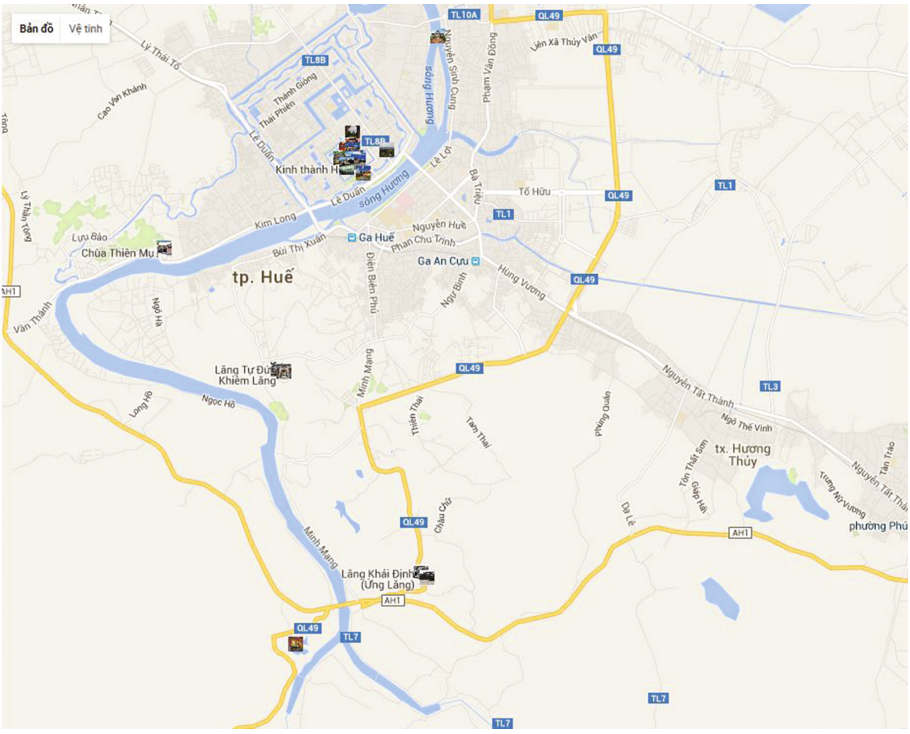

Fig. 4. Map attractive photos based on user's position

6 Conclusion and Future Work

6.1 Conclusion

In this study, we had exploited geotagged resources from social networking services for the purposes of smart cultural tourism development.

The research results indicated that the combination of the semantic tags and media data such as image data bring out many useful information for users during their trip.

Thank to these results, we can foresee that social networking services are likely to be further integrated into the smart cultural tourism in Vietnam and other countries which have many cultural structures tourism.

6.2 Limitations

Using information from social networking services are facing with some difficulties in security such as some photos in Flickr; collecting a list of friends of a user on Instagram, are not allowed because of the privacy of these applications and some user's security mechanisms. These lead to some useful information will not be collected to implement in our system. Therefore, the system is limited by data collected.

6.3 Future Work

In the near future, the consideration of solving big data is one of the goal to research. Because of the size of data is increasing, especially with data on social networking services.

Further, the incorporation of IoT sensors is becoming a new trend. The system will be integrated functions of mobile, sensors to collect information and interactions between different users in the mobile space tourist.

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