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# A Development of Real-time Tourism Information Recommendation System for Smart Phone Using Responsive Web Design, Spatial and Temporal Ontology

**Akkasit Sittisaman, Naruepon Panawong**

***Abstract*: This research presents the development of a real-time tourism information recommendation system on smart phone (RTIRS) using responsive web design. Three key components of the proposed system are temporal and spatial ontology databases which collect tourism information in Nakhonsawan province, i.e., tourism locations, restaurants, accommodations, festivals or traditions. Second, the responsive web design using Bootstrap framework is implemented in order to adapt the display of websites for various screen sizes of smart phones. Third, the real-time tourism recommendation system using PHP and SPARQL is utilized for temporal and spatial ontology search. The experimental results of the real-time tourism information recommendation system show that the system can suitably display tourism information on the different screen sizes of smart phones. The displayed information is specific to users' locations and times which is tourism locations, restaurants, accommodations, festivals, and traditions. The direction to the suggested locations by google map is shown as well. Therefore, the tourists will not miss the important activities and travel effectively. Otherwise, the system can search the tourism information by users' search words which help users to set up the well itinerary planning. The efficiency of the proposed system is excellent which can be seen from the average of F-measure is 95.88%, the average of precision is 93.75% and the average of recall is 98.37%.***

***Index Terms*: Real-Time, Responsive, Spatial Ontology, Temporal Ontology, Tourism.**

## I. INTRODUCTION AND RELATED WORK

Traveling brings happiness to each individuals and families. It helps various types of service providers such as accommodations, restaurants, souvenir shops, and tourism services, increasing income as well. Thai government continuously promotes Thai tourism via multiple activities and channels. In 2016, Thai government had strategic issues about domestic tourism, i.e., driving the revenue growth by means of sustainable tourism, strong communities and good environment. Those activities were in accordance with Thai government tourism policies that aimed to distribute revenue among localities under multiple campaigns: "Muang Tong-ham Plad Plus (12 must-visit cities plus)", "Kao Lao Wa (Tell travel stories)", "Outdoor Fest". In 2017, the government promoted multiple projects: 12 Muang Tong-ham Plad Plus (12 must-visit cities plus)", "Tiew Thai Tei (amazing Thai tourism)", "Pee Tong Tiew Vithi Thai Kae Kai Yang Yung Yun (amazing Thai cultures, sustainable tourism)." In 2018, Thai government intended to boom local economy by means of promoting 55 most interesting cities to visit under the campaign "Amazing Thailand Go Local Tiew Tongtin Thai Choomchon Terb Yai Muang Thai Terb Tow (amazing Thailand go local for community and Thailand growth)". The estimated income from "Thailand Go Local" project is approximately greater than 10,000 million baht a year [1].

The spatial and temporal information, e.g., attractive locations, activities in the areas, opening hours of traveling locations, recommended seasons for travel, festivals or cultures that occur during travel, etc., is crucial to tourists. Most users search for tourism information using web search engine. However, search result shows a large amount of tourism information which has not been classified into categories and some irrelevant information shows up as well. Hence, it is time consuming task for users to select only related websites that suite their needs for travel planning. [2]. Moreover, the number of smartphone and tablet users is increasing each year because the mobility of these gadgets. The survey of the number of computer, internet and mobile phone users during 2013 to 2017 found that the number of computer users is decreased from 35% to 30.8%, internet users is increased from 28.9% to 52.9% and the number of mobile phone users is increased from 73.3% to 88.2% [3]. In 2018, a survey of the internet usage behavior in Thailand shows that the average internet usage hours are longer by 10.5 hours/day, the most activities on internet such as social media is 93.64%, email service is 74.15% and searching for information is 70.75% [4]. [5] shows that the number of smartphone users during 2009 to 2015 tends to monotonically increasing and greater than the number of computer users.

[6] proposed a Context Aware Thai Tourism Recommender System (CAT-TOURS) using Naïve Bayes Model with boundary values for classifying tourism information and a temporal ontology for storing season information.

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Tourism information according to Thai lunar calendar is separated from the temporal ontology. When tourists or users specify traveling dates, the proposed system convert solar calendar dates to Thai Lunar calendar dates. Then the system matches the transformed dates with tourism information that meets the user's expectations and [7] presented the development of a tourism recommendation system for Thailand using the Semantic Web Rule Language (SWRL) and a KNN algorithm to search for the appropriate tourism information. The system allows users to select search options from a menu, for example, accommodation types, food places, attractions types, etc. Then the system matches this user's travel information with the travelling rules stored in SWRL and displays the recommended travel information results. Moreover, [8] developed a personalized recommendation system for travel planning. The system starts from collecting travel requirements from users, eliminating the isolated places and planning the optimal route by greedy travel planning algorithm. The system shows the travel itinerary on google map. However, the tourism information is not real-time because it lacks the geographical coordinate of the attractive location. Since the proposed recommendation system is a computer-based one, it cannot operate on smart phones which have different screen sizes.

According to the factors stated above, the author proposed a development of real-time tourism information recommendation system for smartphone (RTIRS). RTIRS is the web application based on responsive web design. Hence, the website's display size is automatically adjusted to fit various screen sizes. Spatial ontology is designed for collecting attractions while temporal ontology store time positions and durations of festivals or important activities nearby a user's location. This information obtained from RTIRS is helpful for tourists' planning.

## II. METHODOLOGY

The proposed RTIRS consists of three parts: spatial and temporal ontologies, the responsive web design and the RTIRS system architecture. The details are described as the follows.

### A. Spatial and Temporal Ontologies

Spatial ontology is the formalization of the geographical information models (concepts and relationships between concepts) that are sharing among geographic information system (GIS) field. However, the geographical concept models are abstract and generalized from cognition of geographic phenomenon. Consequently, the spatial ontology can be readable both to human and computer. Since, the geographic science is to describe the real geographic structure precisely while ontology is rather an abstract methodology centered on the concept. Therefore, the spatial ontology is utilized for expression of data and resource characteristics. On the other hand, temporal ontology or the ontology of time is utilized for time defining or data clustering using time analysis [9]. In this research, the authors design spatial and temporal ontology which composed of geographical coordinate of the user, date and time for suggesting the tourism information by the user's area, the time duration or the suitable season for travelling. For instance, a user is staying in Paknumpho district, Muang City, Nakhonsawan province, so the recommendation system will advise the user about restaurants in this area during daytime. If the user needs travelling information, the proposed RTIRS will display the geographical coordinate of interested places for the user, such as BigC supercenter and Nakhonsawan Temple. If the user's length of stay matches with religious festivals at the time or in the next few days from the user's length of stay, RTIRS will recommend the information of those festivals to the user. Hence, the user can decide whether to stay longer for attending those festivals.

[10] designed and developed the tourism and temporal ontologies which are separated from each other. Consequently, the travelling information recommendation is time-consuming because the recommendation system has to connect and relate tourism information between both ontologies. Therefore, the proposed RTIRS was designed and developed using spatial and temporal ontologies according to the real-time tourism information which related to geographical coordinate and the length of stay of a user. Hence, users will not miss the important activities, for example, the important religious events and dates (the religious activities and dates are different in each year), seasonal festivals or attractions in each locality, popular restaurants for breakfast, lunch and dinners in the area as shown in Fig. 1.

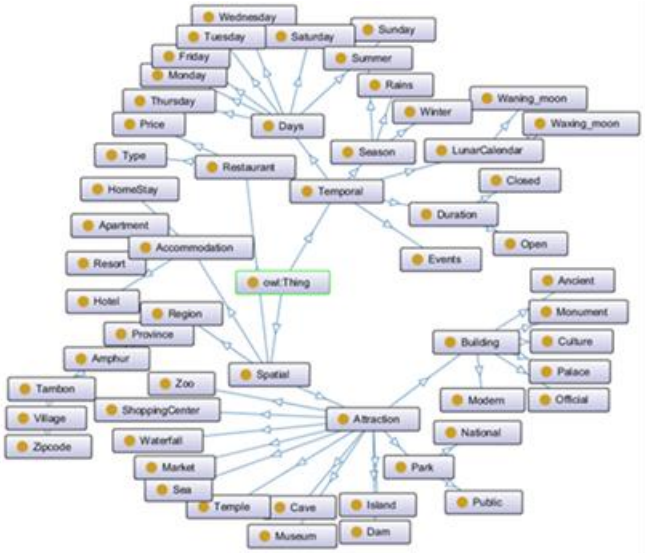


**Fig. 1 Spatial and temporal ontologies**

Figure 1 demonstrates the design and development of the spatial and temporal ontologies for the proposed RTIRS which divided into two classes; "Spatial" and "Temporal" classes. The detail description of each class is as follows:

1) Spatial class has the following details:

1.1 Region collects the tourism data according to areas which have been classified by Thai administrative district which are Province, Amphur, Tambon, Village, and Zipcode.

1.2 Attraction collects interesting places, i.e., Building, Cave, Dam, Island, Market, Museum, Park, Sea, ShoppingCenter, Temple, Waterfall, and Zoo.

1.3 Building is further divided into Ancient, Culture, Modern, Monument, Official and Palace.


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1.4 Park is divided into Public Park and National Park

1.5 Accommodation collects the staying places, i.e., Apartment, Homestay, Hotel, and Resort.

1.6 Restaurant collects restaurant information, i.e., Type and Price.

2) Temporal class has the following details:

2.1 Season collects seasons in Thailand, i.e., Summer, Rains and Winter.

2.2 Days collects official date of attractions, accommodations and restaurants, i.e., Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, and Sunday.

2.3 Duration collects the open hours of attractions, i.e., Open and Closed.

2.4 LunarCalendar collects the important religious dates, i.e., Waning Moon and Waxing Moon

2.5 Events collect the festival information within the considered locality.

### B. Responsive Web Design

Responsive Web is the design of the website that supports multiple screen sizes of gadgets, for instance, computer, smartphone or tablet. The advantage of responsive web is once the web site created, the web page automatically adjusts the display to fit with the screen size. Then, users can access websites regardless of the display sizes or the types of gadgets. The responsive web is implemented in RTIRS using CSS, CSS3 and JavaScript for data sorting, optimize and response to different display sizes.

Web development using responsive web design facilitates users accessing a website with various device types. For example, smartphones or computer displays have different display sizes. Recently, researchers utilized the responsive web design for web applications such as [11] developed an independent study project search system for the department of computer and information technology, Nakhon Sawan Rajabhat University. The experimental results show that the website can adapt the display of the web content to multiple screen sizes. In addition, the F-measure is 95.02%, the average search precision is 94.70% and the average recall is 95.35% that means the efficiency of the search system is high. [12] developed a responsive web-based QR Code for the inventory management in the laboratory of informatics. The developed responsive web-based inventory management supports various cell phone screen sizes and the ease of use. [13] explored the advantages and necessity of the responsive web design in practice through the Department of Homeland Security and Emergency Management's (DHSEM) website.

### C. RTIRS Architecture

The RTIRS architecture shown in Fig. 2 has two operation modes:

1. The system locates the geographical coordinate of the user for real-time tourism information recommendation. The user obtains tourism information, i.e., attractions, accommodations, restaurants, and festivals or events by the area and the duration time of stay.

2. Users enter search words for tourism information query RTIRS searches for tourism information using SPARQL. RAP API is applied for retrieving information and connecting with spatial and temporal ontologies. The website was developed by PHP. The web is responsive and shows the geographical locations of the user, attractions, restaurants, accommodations, and routing using google map.

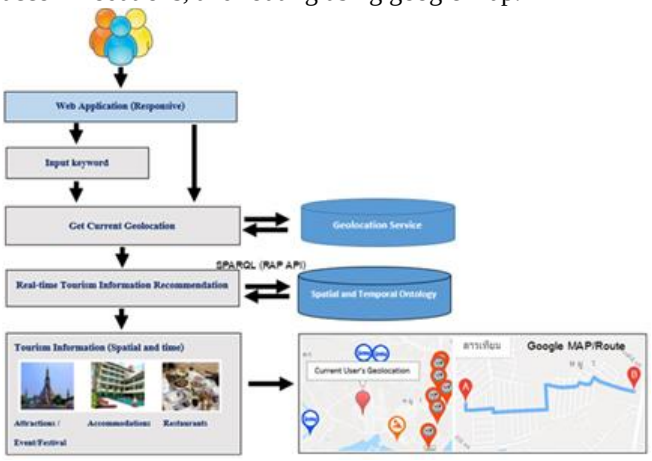


**Fig. 2 RTIRS Architecture**

## III. TESTING AND RESULTS

This research proposed the development of a real-time tourism information recommendation system on smart phone using responsive web design, spatial and temporal ontologies. The system was developed by PHP and Bootstrap Framework. RTIRS retrieves the user's geographical location and then RTIRS displays tourism information (attractions, restaurants and accommodations) nearby user's location as shown in Fig. 3.


**Fig. 3 The responsive web display of tourism information suggested by RTIRS**

Two experiments were performed. 1) Search words and RTIRS displayed correct search results and 2) Real-time tourism information recommendation test. The detail of those two experiments and results are as follows:

### A. Query for Tourism Information

A result from first experiment obtained from RTIRS when a user entered "BigC" as a search word. BigC is an attraction where tourists can shop or dine in various types of restaurants.


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The search results by RTIRS shown in Fig. 4 and a route from the user's location to BigC shown in Fig. 5.

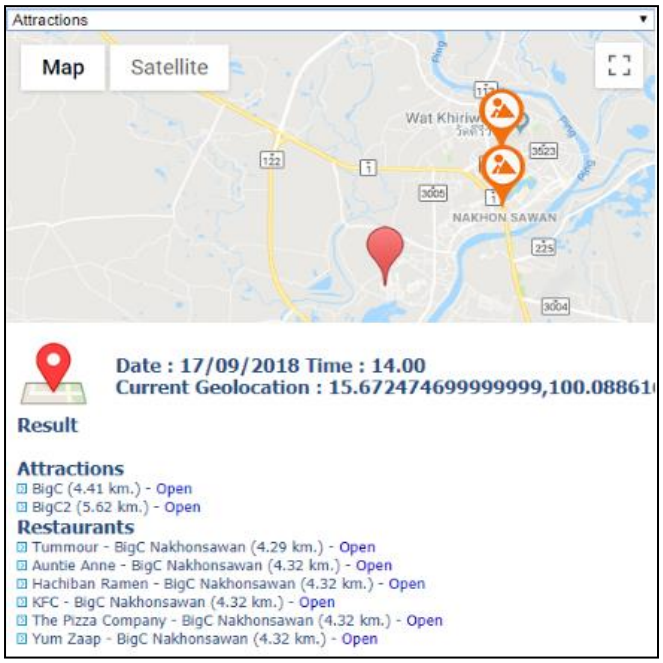


**Fig. 4 The display result of the search word "BigC"**

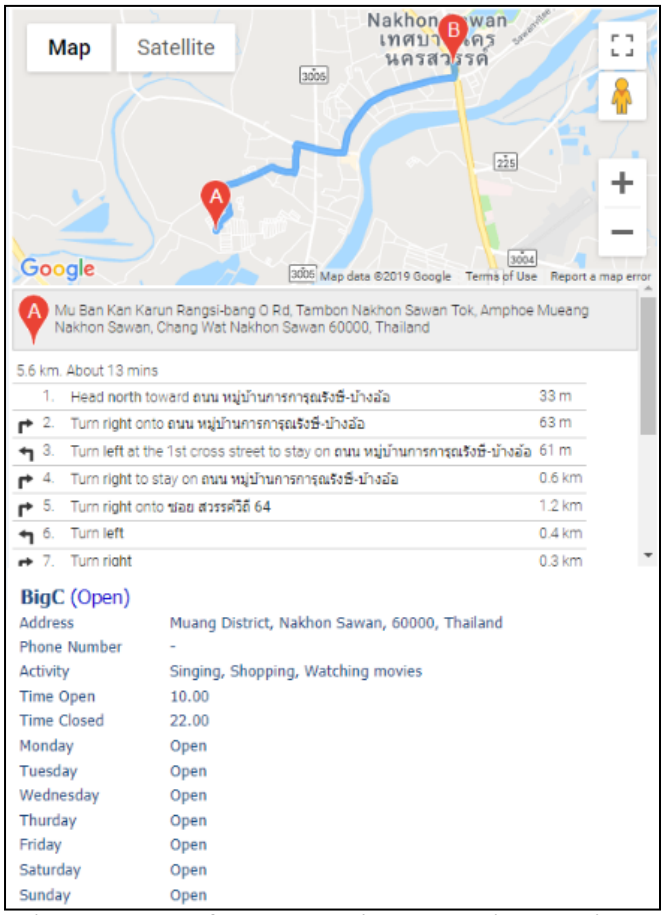


**Fig. 5 The route from the user's geographical location to BigC recommended by RTIRS**

## B. Real-Time Tourism Information

RTIRS recommended tourism information based on geographical coordinate of the user as shown in Fig. 6 and Fig. 7.

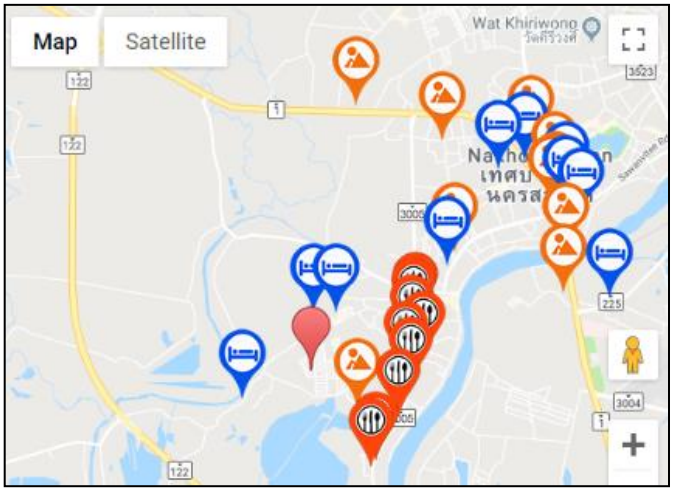


**Fig. 6 Tourism information recommended based on the user's geographical coordinate**


**Fig. 7 Detail of Tourism information recommended based on the user's geographical coordinate**

Figure 6 and Figure 7 shown the real-time information, i.e., attractions, restaurants, accommodations, festivals or holidays or important religious date lists which were recommended by RTIRS. The distances between the user's geographical location and the recommended lists were displayed and the office hours as well. If there is a Buddhist observance day, for example on September 17, 2018, the system recommended the user to make merit at any temple. In addition, RTIRS suggested the festivals in the next few days that tourist should attend as shown in Fig. 8. Therefore, if the tourists decided to stay for two more days, they could attend the long-tail boat racing festival on Chao Phraya River, in front of Nakhonsawan city hall.


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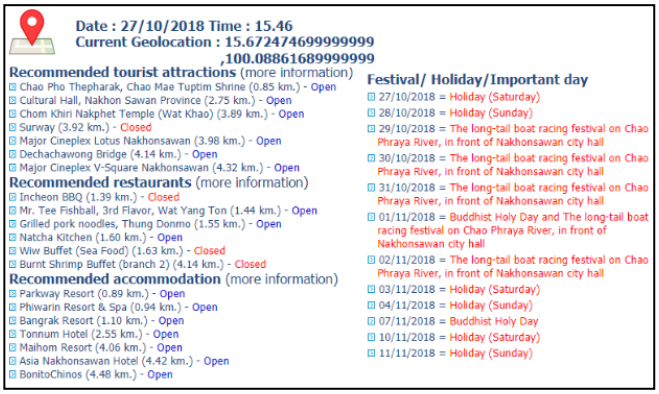


**Fig. 8 Important festivals that tourists should not miss to attend**

### C. The efficiency of RTIRS

The efficiency of RTIRS measured by three metrics: Precision, Recall and F-measure in Eq. 1. Three efficiency testing were performed by 1) the efficiency of tour-ism information recommendation if users entered search words as attractions, restaurants/food types or accommodations, for example, "Big C", "noodles", "Hotel." 2) Tourism information recommendation if users entered search words as the target areas, for example, "attraction Takhli", "restaurant Kao Liao", "accommodations near Big C." 3) Real-time tourism information recommendation based on space and time specified by users. Each efficiency test was performed fifty times by different search words each. The authors tested travelling to the attractions in each district of Nakhonsawan province and fifty important locations recommended by RTIRS based on spatial and temporal tourism information. The efficiency metrics shown in Table I.

$$\text{F-Measure} = \frac{2 * \text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}} \quad (1)$$

Precision is True Positive/(True Positive + False Positive)
Recall is True Positive/(True Positive + False Negative)
True Positive is the right answer, was displayed
False Positive is the wrong answer, was displayed.
False Negative is the right answer, but was not displayed.

**TABLE I: THE EFFICIENCY OF RTIRS**

| Tourism Information Recommendation | P | R | F |
|---|---|---|---|
| 1. Using search words | 100% | 100% | 100% |
| 2. Using Search words as specific region. | 81.25% | 95.12% | 87.64% |
| 3. Real-time based on region and time. | 100% | 100% | 100% |
| **Average** | **93.75%** | **98.37%** | **95.88%** |

Table I show that the average F-measure was 95.88% which is very good, the average Precision was 93.75% and the average of Recall is 98.37%. Since when users used search words as specific regions, RTIRS delivered some resulted information unrelated to the users' search areas. For instance, the user searched for restaurants in Krok Phra district thus the user's search words are "restaurants Krok Phra" but the search results included "Kuay Tiew Moo Yang Tung Don Mo (on the route to Krok Phra district)" where is in Muang district. Since the address information of this restaurant included the word "Krok Phra" in the address. The similar result to the example beforehand was "Noodles Neon Makok" (Neon Makok is a subdistrict of Phayuha Khiri district) was the search words. The results showed "Heer Tee Noi Noodles (Noodles Neon Makok)" where located in Muang district as well, because this noodles restaurant has two branches (Muang and Phayuha Khiri district) with the same name. Therefore, if the geographical location analysis is modified in the pro-posed recommendation system, it will improve the system's efficiency and deliver the recommended tourism information that is more suited with users' requirement.

## IV. CONCLUSIONS AND FURTHER WORK

This research proposed the development of a real-time tourism information recommendation system on smart phone using responsive web design, specifically tourism information recommendation in Nakhonsawan province. Spatial and temporal ontologies were applied for tourism information suggestion to tourists based on their geological coordinates and the times of stay. The tourism information includes office hours of attractions, restaurants, accommodations, festivals, or important traditions that tourist should not miss to attend. Furthermore, the system displayed the route between the user's geographical location and attractions, restaurants and accommodations via google map. Therefore, tourists should not get lost and should not miss every important festivals and events. In addition, RTIRS supports the entered search words by users. The system recommended the tourism information that most matched with the tourist' need. The tourism information recommended by RTIRS is very useful for tourism itinerary planning of tourists or businesses. The efficiency of the proposed system is very high since the average F-measure was 95.88%, the average Precision was 93.75% and the average Recall was 98.37%.

Although, the proposed RTIRS can efficiently recommend the real-time tourism information to users, the system cannot recommend the useful tourism information for users in case of the typographical search words or unknown search words entered by users. The authors will include tourism information of all provinces in Thailand in the future. The ISG algorithm will be applied to name similarity finding by using co-occurrence analysis. Hence, users can obtain the proper information they need. In addition, the natural language will be utilized for analyzing Thai language queries in order to advance the real-time tourism information recommendation system to be the real-time intelligent tourism information recommendation system.

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