Design of a Cloud-based Bike-fleet POI Touring Service Platform

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Abstract

Travel lights are more and more popular. Many residents and travelers enjoy traveling using bikes in Taiwan. Hence, this study designs a Cloud-based Bike-fleet POI Touring Service Platform, which is called C-BOOST, to help people make travel plans. C-BOOST is composed of Bikers and a Cloud-based Digital Convergence Server (CDCS). Bikers can use a smartphone to get potential Point of Interests (POIs), to get Location-based Services (LBSs), to update traveling itineraries and to manage bike-fleets. Cloud-based Digital Convergence Server is based on Mass Behaviors Model, which provides RSS, Google App Engine (GAE) and Quality Control Adaptor services. Quality Control Adaptor is composed of Ant Colony Optimization (ACO) algorithm, Bayesian Network and Ontology by users’ preferences and GPS values, providing potential POIs for bikers. C-BOOST can provide more suitable POIs for bikers.

Keywords: Point of Interest (POI), Ant Colony Optimization (ACO) algorithm, Mass Behavior Model, Bike-fleet Management and Google App Engine (GAE).

1 Introduction

Recent years, many residents and travelers enjoy using bikes traveling around Taiwan, which is called travel lights. When a large number of bike-fleet members, the captain should take care of these members. Furthermore, the captain should pre-survey POI information about this tour, which includes historical background, culture, attractions characteristics, etc. When a bike-fleet wants to visit localized characteristics, they should select one of following methods. (1) To hire a specific tourist guide. Although this way not only saves time but also get wanted information, it increases travel costs. (2) To search and collect needed information via Internet or Hardcopies. Although this way can get information, most of this information is useless during your traveling. (3) To use personalized travel recommender systems [5, 12]. Although these system can suggest POIs, these systems lack of high flexibility for traveling. A bike-fleet will be changes by human influence factors and natural influence factors. (1) Human influence factors include stamina, health, ages and so on. (2) Natural influence factors include topographies, climates, road situations and so on. Hence, it is an important issue for researchers to integrate contents, services, applications and appliances into a POI Touring Service Platform. Three issues are needed to be considered when designing a cloud-based bike-fleet POI touring service platform, which are adaptivity, interactivity and integrity.

(1) Adaptivity. Bike-fleet-based traveling schedules are usually lack of adaptivities changing it. If it is rains or traffic chaos, bikers will difficult to follow schedules. To tackle this problem, Quality Control Adaptor provides potential POIs by the proposed reference engine, which is composed of Ant Colony Optimization (ACO) algorithm, Bayesian Network and Ontology by users’ preferences and GPS values [3, 9, 10].

(2) Interactivity. The captain, which is called the cluster head, should handle and interact with members. Hence, android-based digital convergence services is designed for interacting with other bikers [6].

(3) Integrity. Most POI information are not easy collected, separated anywhere. Bikers are not easily integrate with blogs, websites and guidebooks into tours. It is an important issue to integrate POIs information by integrating Google App Engine (GAE), Really Simple Syndication (RSS) and Dropbox for bikers [1, 6].

For aforementioned three issues, this study designs and proposes a Cloud-based Bike-fleet POI Touring Service Platform, which is called C-BOOST, to help bikers make travel plans. C-BOOST is composed of Bikers and Cloud-based Digital Convergence Server (CDCS). Bikers use a smartphone to get potential POIs, to get Location-based Services (LBSs), to update traveling itineraries and to manage bike-fleets. Bikers can enjoy traveling according to different POIs with the GAE platform. CDCS automatically pushes and delivers serialized contents depending on ontology and ACO algorithm by users’ preferences and GPS values.

The rest of this paper is organized as follows. Section 2 describes related work. Section 3 describes the infrastructure and system components of C-BOOST service platform. Section 4 describes the implementation of C-BOOST service.
platform and simulates system performances. Finally, Section 5 concludes this work.

2 Related Work

According to the maturity of travel-lights, to combine POIs with Location-based services (LBS) can provide more suitable traveling experiences. Many researchers have focused on designing and developing many kinds of travel recommender systems. H. Billhardt et al. proposed an event-based architecture for dynamic fleet management [2]. The proposed system can realtime get statuses and locations of vehicles and then dynamically dispatch these vehicles by dynamic coordination module. Q. Song et al. proposed a multi-criteria formulation of the bicycle routing problem and an optimum multi-label correcting algorithm for finding a full set of Pareto routes [8]. The proposed a hierarchical clustering-based route selection method that can identify the most representative routes for users. Z. Yu et al. proposed a recommending travel packages based on mobile crowdsourced data, which is composed of user and location modeling, recommendation engine, and mobile user interfaces [12]. This system not only helps users find interesting locations but also generates travel packages consisting of different types of locations and visiting sequences. Q. Lin et al. analyzed the characteristics of the existing travel packages and developed a tourist-area-season topic (TAST) model [7]. This TAST model can represent travel packages and tourists by different topic interests and distributions. Y. Yu et al. designed and evaluated an intelligent tourist guide system that runs on Android tablets with GPS feature [11].

Most of travel recommender systems provide route suggestions for users to visit POIs. Although these systems can solve the problem of adaptivity, they are not able to easily support functions of interactivity and integrity. A well designed situation-aware POI touring service platform not only includes providing needed suggestions but also accommodates with digital convergence services for users. Hence, this study designs and proposes a Cloud-based Bike-fleet POI Touring Service Platform (C-BOOST) for bikers depending on their preferences, potential Point of Interests (POI) and Location based Services (LBS).

3 System Architecture

The system architecture of Cloud-based Bike-fleet POI Touring Service Platform (C-BOOST) is illustrated as Fig. 1. C-BOOST is composed of Bikers and Cloud-based Digital Convergence Server. Related components are described as follows.

3.1 Bikers

Bikers not only can get information and services from CDCS but also can construct a bike-fleet with other bikers. When a biker sent a grouping message to CDCS, CDCS will multicast this message to other bikers by locations and preferences. Hence, the functions of bikes management and bike-fleet management are important.

3.1.1 Biker Management

Figure 2 illustrates the function of biker information management. User information includes name, age, sex, travel time, average speed and so on, which will be packed and delivered by Extensible Markup Language (XML) format and Resource Description Framework (RDF). RDF can present properties and classes by XML-based documents. Bikers will be divided into several groups, which are with the same preferences.

3.1.2 Bike-fleet Management

Bike-fleet management provides two scenarios. One is interest mode and the other is family mode. (1) Interest mode. A user can set interests or preferences to get POIs suggestions by C-BOOST. Furthermore, a user can sent a grouping message to other bikers and group up a bike fleet. C-BOOST can design traveling route by required POIs. The detail
working flowchart is illustrated as Fig. 3. (2) Family mode. Family members are with different interests and ages. Hence, C-BOOST will manage participants and compute suitable traveling routes for users by proposed reference engine. Quality Control Adaptor. The detail working flowchart of family mode is illustrated as Fig. 4.

![Working flowchart of interest mode](image)

**Figure 3: Working flow of interest mode.**

Furthermore, bikes can use a smartphone or a triaxial accelerometer sensors to evaluate road slopes. If the slope is decrease or increase suddenly, C-BOOST will send warning messages to group members, which shown as Fig. 5 and 6. Figure 5 illustrates the data delivery mode by sensors. Figure 6 illustrates the scenario of changed slopes when two bikes in riding. Bikers can speed up or slow down to adapt different situations, after receiving warning messages.

![Data delivery by one hop sensor mode](image)

**Figure 5: Data delivery by one hop sensor mode.**

![Warning messages by changed slope](image)

**Figure 6: Warning messages by changed slope.**

### 3.2 Cloud-based Digital Convergence Server

Cloud-based Digital Convergence Server (CDCS) is responsible for providing potential POIs and traveling routes for bikers and bike-fleets. CDCS provides RSS, Google App Engine (GAE) and Quality Control Adaptor, which is based on Mass Behaviors Model. Quality Control Adaptor is composed of Ant Colony Optimization (ACO) algorithm, Bayesian Network, Ontology and Mass Behaviors’ Model, to provide potential POIs. Influence factors are divided into long period factors and short period factors, which are composed of history events and emergencies. Figure 7 illustrates influence factors by ontology structure.

![Influence factors of Quality Control Adaptor](image)

**Figure 7: Influence factors of Quality Control Adaptor.**

1. **History event.** History event is defined as experiences by members. A member can share experiences to others and set a traveling route. Hence, influence factors includes average ages, preferences, available riding time, etc. Figure 8 and 9 illustrate reasoning results by Bayesian Networks.

![Bayesian Network Model](image)

**Figure 8: Bayesian Network Model.**

2. **Emergencies.** Emergencies is defined as the scheduled traveling route is unstable for members, e.g. weather, members suddenly changed and so on. Hence, C-BOOST will trigger Mass Behavior’ Model for this bike fleet.

In Quality Control Adaptor, the suggested traveling route is computed by ACO algorithm, which is illustrated as Fig.10. ACO will dependent on the user’s locations, destination locations, interests, weather and so on, as Data N. Suitable potential POIs will be gathering and setting up Ontology for
this user. The detail ACO algorithm is illustrated as Table 1 [3, 10]. The reasoned route is a suitable traveling schedule for bikers.

After reasoning, CDCS provides information backup module, RSS module and Cron module, which is illustrated as Fig. 11. Figure 11 illustrates related components of RSS module, which includes content provider, content aggregator and headline viewer. (1) Content provider is responsible for providing news and RSS seeds for users. These information is based on XML formats. (2) Content aggregator is responsible for collecting different RSS resources, distinguishing these information to different classes, and customizing it to different formats. Subscribers can search needed RSS items by content aggregator. (3) Headline viewers are responsible for scribbling and reading related RSS contents by different devices.

Figure 12 illustrates Google App Engine (GAE) working flowchart in CDCS. Bikers can set time schedule by Cron module to trigger GAE services, which is responsible for reminding traveling schedules and RSS contents.

4 System Implementation

This section presents implementations of C-BOOST. Figure 13 illustrates implemented interfaces, which includes traveling, news, backup and GAE services. (1) Traveling. Bikers can set and have a specific traveling schedule, which is reasoned by personalized POIs. (2) News. Bikers can scribble and read wanted news by RSS. (3) Backup. Bikers can use Dropbox to backup traveling contents. (4) GAE service. GAE service can help bikers to set individual schedules in detail. Furthermore, C-BOOST use an acronym of Friend of a friend (FOAF)-a-matic to set up ontologies. FOAF is based on XML and Resource Description Framework (RDF) to divide bikers into different groups, illustrated as Fig. 13. Quality Control Adaptor provides potential POIs by a biker’s location, interests and local/destination weathers. Figure 14 illustrates input data and working flow of ACO algorithm. Figure 15 illustrates the working flow of ACO results. Figure 16 illustrates the suggestions for a biker.

The suitable traveling route is reasoned by Bayesian network model, which illustrated as follows. (1) Quality
$P(X|p) \cdot P(p) = P(X_1|p) \cdot P(X_2|p) \ldots P(X_n|p)$  \hspace{1cm} (1)$

$P(X|p)$ is a new case and $P(p)$ is the enjoy probability of route. Hence, C-BOOST compares with personalized travel system and assistive navigation system [4, 12], which illustrated as Fig 17, 18 and 19. Figure 17 illustrates the query time of potential POIs. Figure 18 illustrates the system execution time for computing a suitable traveling schedule. Figure 19 illustrates comparisons of traveling time.

5 Conclusion

Control Adaptor records influence factors, which are number of tourists, sex, POIs, local weather and temperature. (2) According to influences factors, Quality Control Adaptor will reason the probability of reasoned route by Bayesian network model (P), which is shown as formula (1).
This study designs a Cloud-based Bike-fleet POI Touring Service Platform, which is called C-BOOST, to help people make travel plans. C-BOOST is composed of Bikers and Cloud-based Digital Convergence Server. The proposed C-BOOST can efficiently resolve mentioned three issues problem of adaptivity, interactivity and integrity.

(1) To tackle the problem of Adaptivity, C-BOOST uses Ant Colony Optimization algorithm, Bayesian Network and Ontology by users’ preferences and GPS values.

(2) To tackle the problem of Interactivity. C-BOOST uses Android-based digital convergence services is designed for interacting with bikers.

(3) To tackle the problem of Integrity. C-BOOST uses Google App Engine, Really Simple Syndication and Dropbox for bikers.

Furthermore, system stacks and flowcharts are presented.

The proposed C-BOOST can be a reference model for researchers.

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References


