Intelligent Content Management System for Tourism Smart Mobility: Approach and Cloud-based Android Application

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Abstract: Intelligent content management systems have become more popular over the last few years in the tourism industry due to the significantly increasing impact on revenue. Such systems are the part of the smart mobility concept. Smart mobility allows tourists to become more comfortable with transportation in an unknown city by providing interesting information about places seen during their trip. Traditional taxies provide quick transportation from the point A to point B but people sometimes are interested in seeing attractions during their trips and are willing to spend more time and money to do so. Integration of the smartphone application with the vehicle infotainment system provides opportunities of new smart services construction that is based on information from vehicle sensors and Internet connection as well as utilization of in-cabin infrastructure and communication with the driver (suggesting the route preferred by the tourist, speed while going around attractions, adjust the temperature, music, and etc.). The paper presents an approach to smart mobility system development and its evaluation by showing the tourist video information about attractions around.

1 INTRODUCTION

Information technologies fill different aspects of our lives with innovative services supporting various activities. Development of artificial intelligence technologies, in turn, improve the level of support (e.g., Barolli and Enokido, 2017).

One of such supporting solutions is intelligent personal assistant. Such assistants are basically software applications that are capable of helping people in their everyday activities (Santos et al., 2018). Intelligent personal assistants can access information from databases and other sources to guide people through different tasks, applying learning mechanisms to acquire new information about user preferences.

Tourism is a rapidly developing area of human activity, where information technologies are used very intensively. Information on attractions, transport schedules, electronic maps, feedback from other tourists, etc., all this information can be acquired from various sources and used for improving the tourist experience (Li et al., 2017; Ukpabi and Karjaluoto, 2017).

However, the amount of available information is becoming overwhelming and its manual processing is getting difficult. This is where application of artificial intelligence with its capability of personalized information analysis can be beneficial. Such systems can not only extract required information from various sources, but also adapt to tourists' behavior, interests and preferences (Xiao et al., 2017; Wadekar at al., 2017; Li and Cao, 2018; Smirnov et al., 2018).

Integration of such intelligent tourist support systems with vehicles would produce a new experience. The in-vehicle services could provide for more precise positioning, speed and direction estimation, route prediction based on the navigation system, etc. The paper presents the intelligent tourist support system utilizing in-vehicle services. Described earlier, the approach (Smirnov et al., 2018) has been implemented in an Android-based system. The paper concentrates on intelligent information extraction from various sources and cloud-based application architecture.

The structure of the paper is as follows. The approach is explained in section 2. The information extraction and application structure are presented in section 3. Section 4 explains implementation details

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and demonstrates the user interface. Finally, remarks are given in the conclusion.

2 STATE-OF-THE-ART

Today information availability through Internet makes it possible for tourists to search and discover a significant amount of interesting information on their own. This gives a rise to the individual tourism, when tourists travel by themselves and use various services as assistance and guiding.

The tourist sights (palaces, museums, parks, etc.) are also searching for new ways of using information technologies to attract more tourists, providing for smart audio tours, interactive information kiosks, and other (Smirnov et al., 2017a; Giuseppe et al., 2014). As a result it has become more interesting to spend time at the attractions than just casting a glance, taking a picture and walking away.

Usage for smart services and mobile applications makes it possible for the tourists to better plan their routes, see more attractions and spend more time there compared to "old fashioned" means such as booklets and paper maps (Li and Liew, 2015; Modsching et al., 2007). Such new services help tourists to conduct some research before travelling to better plan the trip and find convenient travelling means (such as public transport, taxi services, etc.)

Transport providers, in turn, also recognise the appearance of new opportunities and increasing amount of individual tourists. Most of the tourist cities have a network of hop-on-hop-off buses, which drive by a predefined route from one attraction to another, and tourists can enter and leave such bus without a need to buy a ticket every time. Some cities have 2 or 3 day tickets for public transport that are usually enough for covering the travelling needs of individual tourists.

This makes it possible to increase the utilization by each customer, spread the use over the whole day, and allow the operator to get more utilization out of each bus, instead of optimizing for peak periods.

Taxi companies do not only introduce mobile apps that make it possible to order taxi for a predefined price without a need to negotiate with a driver who may not speak the tourist's language, but also seek to new tourist-oriented business models.

For example, UberTour launched by Uber combines the idea of the Uber taxi (when one can reserve a car using a mobile app) and hop-on-hop-off buses (with a possibility to enter the car and leave it at some pre-defined stops associated with attractions).

The conducted analysis of the available tourist-oriented services and mobile applications (Ambrosino et al., 2010; Price, 2015) indicates that there is a tendency to provide the tourists with proactive information support taking into account not only the current location but also personal preferences, weather and other context information (Cowen, 2015; Smirnov et al., 2014b; Gerhardt, 2015; Staab et al., 2002; Hasuike et al., 2015). It is still an actual task to develop a system that would be capable to :

- collect information about attractions from different sources and recommend the tourist the best for him/her attraction images and descriptions;
- generate recommended attractions and their visiting schedule based on the tourist and region contexts and attraction estimations of other tourists. The tourist context characterizes the situation of the tourist, it includes his/her location, co-travelers, and preferences; the region context characterizes the current situation of tourist location area, it includes such information as weather, traffic jams, closed attraction, etc.
- propose different transportation means for reaching the attraction;
- update the attraction visiting schedule based on the development of the current situation.

3 AN APPROACH

The conceptual scheme of the smart mobility system is presented in Figure 1. Based on the schedule analysis (e.g., hotel check-out before 11AM and flight at 08PM) the system proposes a tour that would fit the schedule and finish at the airport. Alternatively, the person can schedule a tour of his/her own. The tour takes into account the person's preferences (preset and revealed via collaborative filtering techniques) and the current situation at the location (season, weather, traffic jams, etc.) based on the earlier developed personalized tourist assistance service TAIS (Smirnov et al., 2017; Mikhailov, Kashevnik, 2018). The person can modify the recommended tour and share with other tourists. The driver picks up the tourist(s) at the predefined time and follows the route loaded into the car's navigation system automatically via the car connectivity means. Personal electronic devices (such as smartphone) could be used during the tour for narration, imagery and video synchronized with the vehicle's location

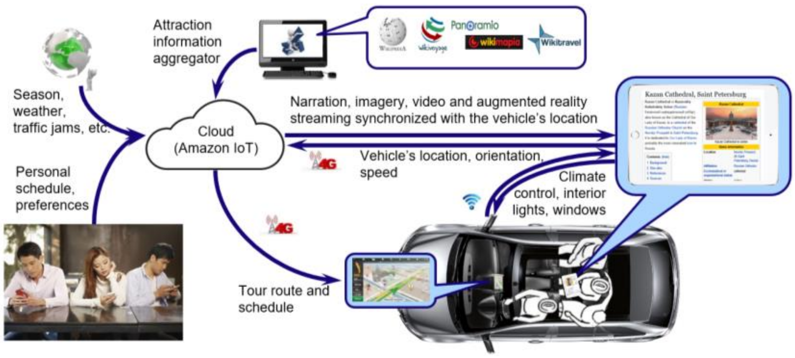

Figure 1: Conceptual scheme of the smart mobility system.

and speed. The support is based on the ad-hoc "on-the-fly" combination of the available information pieces (pre-recorded narration, images, etc.) in the personalized context-aware manner.

4 CONTENT MANAGEMENT

The proposed intelligent content management system consists of smartphone application and cloud application. Smartphone application is aimed at on-the-fly intelligent information provision to the tourist while the cloud application is utilized for attraction information accumulation and smart services construction such as context determination and recommendation generation.

4.1 Smartphone Application

The reference model of the developed smartphone application is presented in Figure 2. The tourist interacts with the graphical user interface that provides the following functions.

- Attraction page generation function is aimed at presenting the user the accessible on/offline attraction database content about the chosen attraction. Attraction page includes the text information, audio and/or video description, and or pictures related to the attraction.
- Map generation function is used by the tourist to see his/her location and accessible attraction around in the interactive map. The OpenStreetMap service is used for these purposes.
- Path calculation function provides the optimal path (by time or by distance) from the tourist location to the chosen tourist attraction.
- Route calculation function is used to suggest the tourist acceptable attraction visiting route based on the current situation in the region incorporating his/her preferences.
- Proactive recommendation function allows the mobile application to generate personalized tourist context-aware recommendations and propose in proactive mode attractions that are better to attend for him/her.
- When the tourist reaches their attraction the intelligent narration function is used to present him/her information about the attraction. Based on the vehicle speed and importance of the attraction the length of the narration should be calculated (length of the text, length of the audio, or length of the video).

Such functions as attraction page generation, proactive recommendations, and intelligent narration are the core functionality of the content management system and implemented in the tourist smartphone and they do not require internet connection. The extended functions such as map generation, path calculation, and route calculation are implemented in the cloud application.

The database module is used to store information about attractions in the offline attraction database in the tourist smartphone and provide this information to the graphical user interface. Offline attraction database is synchronized with the cloud application where it is generated based on accessible information from OpenStreetMap, Wikipedia, and Expert Knowledge. The database module supports the following functions.

- Attraction description storing that incudes information in text form.
- Attraction media that includes information in audio, and/or video, and/or pictures.
- List of attractions function that generates the list of attractions in the tourist location area.

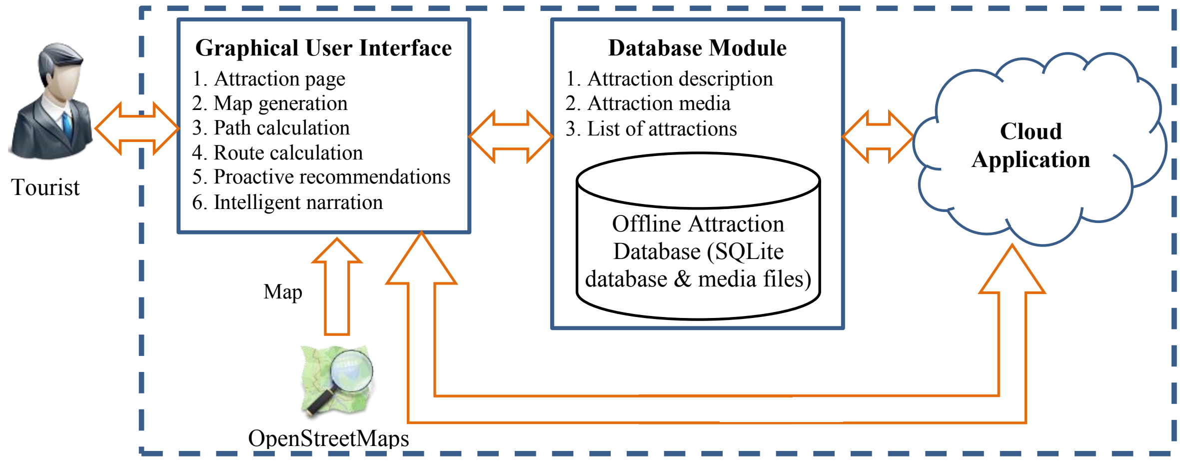

Figure 2: Reference Model of the Smartphone Application.

- Text information about attractions as soon as their location is stored in SQLite database. The media information that includes audio, video, and pictures is stored as a file in the filesystem.

4.2 Cloud Application

The reference model of the developed cloud application is presented in Figure 3. The model consists of several services that are implemented in Docker containers: Database Manager Service, Nginx Web Service, Reverse Geocoding Service, Recommendation Service, Route Planning Service.

The Database Manager Service automatically creates an attraction database based on the information from OpenStreetMap and Wikipedia. The OpenStreetMap is used to select the list of attractions in the location region while the Wikipedia contains the text description and pictures of the attractions. The Database Manager Service supports the following functions.

- Attraction viewing uses the json format that is used by the smartphone application to get attraction information.
- Attraction management function supports the adding, removing, and updating of attractions in the attraction database as well as their text & media description.
- Region creation function allows the creation of new regions and the construction of the attraction database for this region based on information from OpenStreetMap and Wikipedia.
- Offline DB creation function provides the ability to create the SQLite database that can be downloaded by the tourist for local utilization.

The Attraction Database is implemented using the PostgreSQL database management engine.

The Nginx Web Service provides the ability to manage the attraction database by tourism experts. The service provides the web interface for the attraction management function of the Database Manager Service. It supports the adding, removing, and updating of attractions in the attraction database as well as their text & media description.

The Reverse Geocoding Service is implemented to determine the tourist location city by coordinates. It uses the GeoNames web service for this purposes.

The Recommendation Service implements the artificial intelligence functions of the developed content management system. The main function of the service is to organize the attraction visiting list based on the user preferences and context situation in the region. The collaborative filtering approach is used for recommendation generation utilizing the tourist experience with content management system in the past.

The Context Service provides context situational data to the content management system. At the moment of service, it takes into account the following information: weather, traffic jams, user context. All this information is then incorporated into the intelligent recommendations generation for the tourist.

The Route Planning Service functions are: route creation and path creation. Path creation is used for shortest path creation between the tourist location and the chosen attraction. The route creation is the intelligent function that finds the attractions that are the most interesting for the tourist based on his/her preferences and context situation in the region (weather). Based on this list and context situation (traffic jams) the service generates the route that is

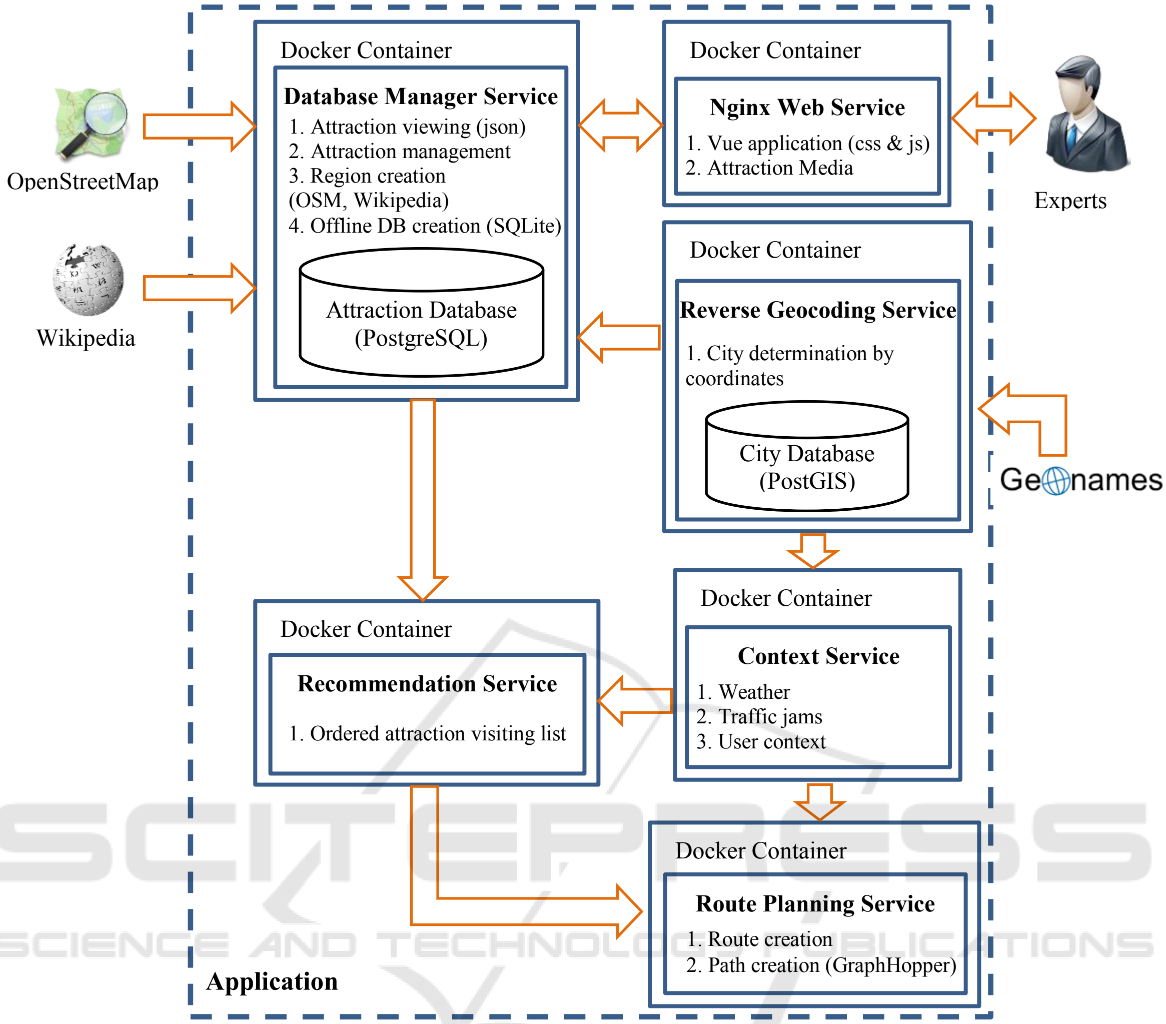

Figure 3: Reference Model of the Cloud Application

most suitable for the tourist to move from one attraction to another.

5 IMPLEMENTATION

The developed intelligent content management system shows the tourist information about attractions in a proactive mode (Figure 4 and Figure 5). It supports the function of database download and utilizes it to provide the tourist information without the Internet connection. On the left side of the screen, the list of ordered attractions is shown. The tourist can see the pictures related to his/her location and the region map. The middle of the screen shows the offline attraction database manager function that shows what the information the database system has at the moment for St. Petersburg and Bologna. The right screen shows the information about the attraction chosen by the tourist.

When the tourist is riding in a vehicle the system automatically determines the movement direction and recognize the side where the attraction is located and notifies the tourist regarding the direction to the attraction (left, right) and presents images and audio/video/text information about it (Shilov et al., 2018). Based on information in the database, the tourist preferences, and context situation (speed) the system plays pre-recorded narration.

To test the performance of the proposed system the attraction visiting plan has been generated, based on data from the of St. Petersburg city in the Android emulator. The computer specification is the following: Intel(R) Core(TM) i7-8700 CPU @3.20GHz process, 16 Gb RAM, 1 TB HDD.

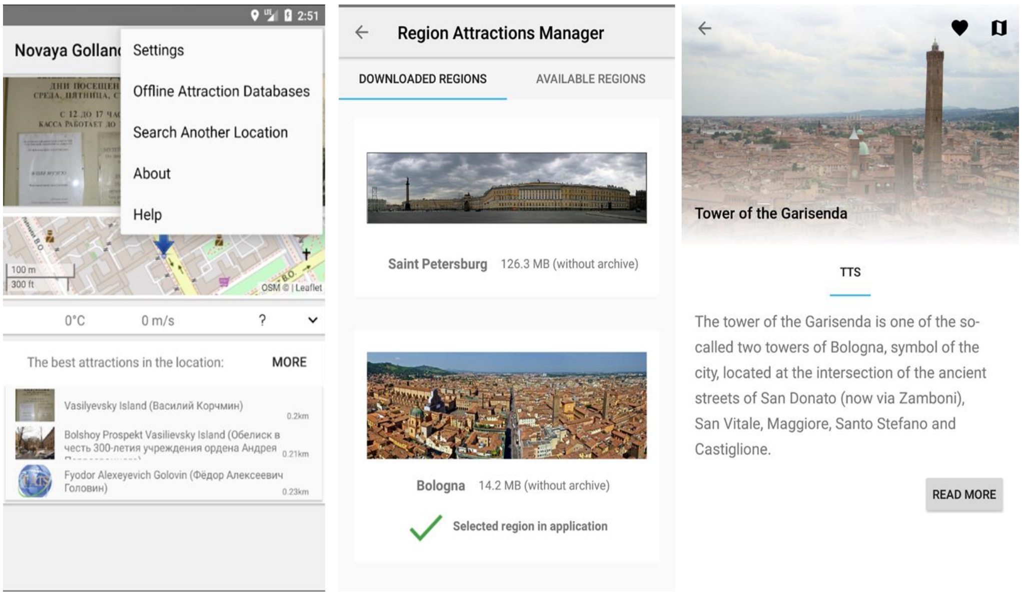

Figure 4: Screenshots of smartphone application: the main screen and offline database download window.

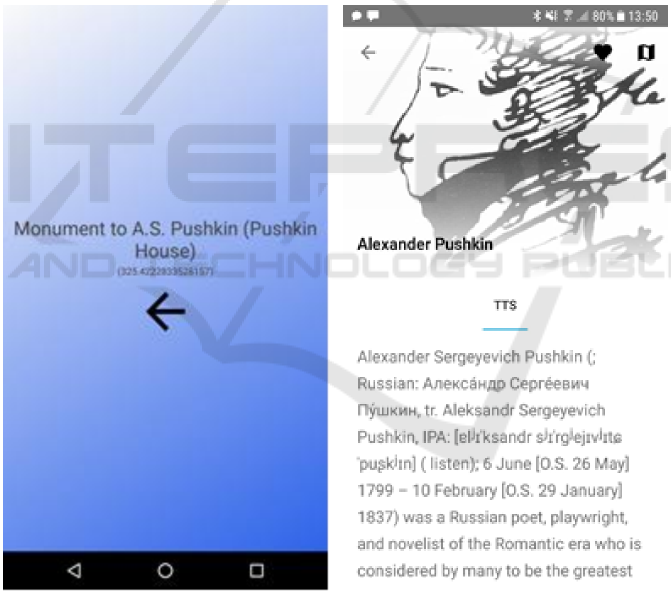

Figure 5: Smartphone application showing direction to the attraction (left) and attraction description (right).

Each attractions contains general information, five keywords, and three images. As a result, sets of 1 000, 5 000, 10 000, 15 000 and 20 000 attractions have been formed. Figure 6 contains information about overall database size for each attraction set and Figure 7 represents offline database download time. The database includes textual information in the SQLite format and graphical data such as images in the separate files. At the moment attraction database for St. Petersburg contains only 1 000 attractions. 20 000 attractions is highly enough for storing information about European city capital. This kind of database requires ~ 4 Gb of memory on a smartphone. A small drawback of such amount of data is quite a long time downloading offline databases (around of 35-40 minutes for 20 000 attractions dataset). This issue can be addressed by loading the offline database in a background thread and processing available data in parts. As Figure 8 shows the attraction textual data retrieving applicable for this amount of information.

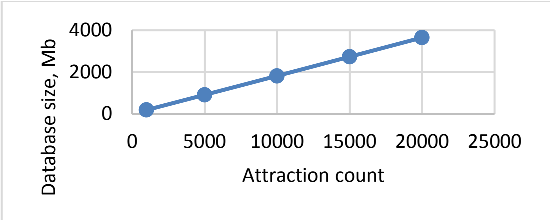

Figure 6: Relationship between offline attraction database size and attraction count.

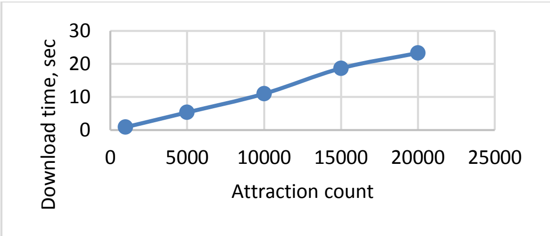

Figure 7: Relationship between offline attraction database downloading time and attraction count.

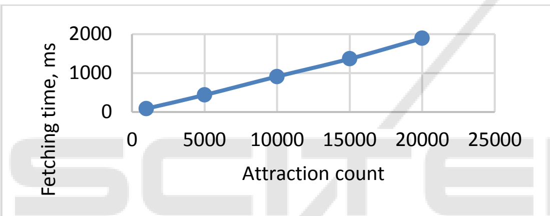

Figure 8: Attraction search time dependency on attraction count in the considered region.

6 CONCLUSIONS

The paper presents an intelligent content management system for tourism smart mobility. The presented system is developed for the tourist smartphone and cloud service. The core functions are supported by the smartphone directly and the tourist does not need to have internet connectivity. Some functions are supported by the cloud service and the tourist will need to have an internet connection to use them.

For the future work authors are going to develop the tour guiding application using Applink API, running on the tourist's Android-based device, implementing the proposed approach, and capable of communicating with the proposed cloud service. Development of the intelligent application prototype supporting interactive context-dependent guidance is continued with additional features to be implemented (higher level of personalization, tour planning, feedback accumulation for collaborative filtering).

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