Proceedings of the Federated Conference on Computer Science and Information Systems pp. 281–287 DOI: 10.15439/2017F188 ISSN 2300-5963 ACSIS, Vol. 11

Just Walk: Rethinking Use Cases in Mobile Audio Travel Guides

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***Abstract*—In this paper we examine a number of solutions used in developing multimedia guiding systems for travelers. We pay particular attention to existing mobile audioguide systems and the capabilities they provide for tour creators. The major contribution of this work is to propose a model that would be appropriate for better tour recommendation and playback automation of outdoor travel tours with using geo-positioning. Specifically, we make an effort to advance a *just walk* concept, and to resolve a number of client-server data synchronization issues in process of tour modification by both tour creators and its users.**

I. Introduction

WHILE traveling, people often want to learn more about the places they discover. Despite there are travelers who prefer careful forethought of a journey, sometimes tourists might not be well prepared for a journey: they believe that they are able to know everything in place, and not due to prior preparations. People often rely on support of professional guides and expect that will tell them all the important stories. However, for many possible reasons, professional guides are not always available:

- Guided excursions might take more time that a traveler expect to spend in a certain place;
- There might be no guide available right now;
- Excursions might be offered not in a language that a traveler can understand.

Rapid development of facilities provided by portable devices (such as smart phones or tablet computers) dramatically changed usage models that we would expect to get from digital solutions accessible virtually at any moment. Fusion of multimedia and mobile technology is one of tangible consequences of human-centric systems evolution [1] including the domain related to design and development of information systems for travelers.

Even those travelers who prefer not to spend much time in pre-journey cultural investigations and careful forethought of their outings, would not like to be passive customers listening to the stories told by a guide: they might want to control the process and to be able to select guiding services on the way. They would also expect to have some flexibility in changing possible itineraries and points of interest as well as in sending their feedback to tour creators and to other travelers just in the moment when they are en route. A possibility of communication between different devices (directly or via special servers) opens totally new perspectives in arranging traveler collaboration by sending different kinds of notifications and hints aimed at actualizing current tour information and its conditions. The next obvious factor is a possibility to integrate tour information display with the geographical maps and geolocation features of present-day mobile devices. Thus, state-of-the-art information services for travelers are developing towards better user personalization, tour customization, extending possible usage scenarios, and improving tour suggestions on the way [2], [3], [4].

Variability of possible tours suggested to a user is especially important in big cities where a traveler might be lost in the ocean of possible sightseeing tracks with a big number of important attractions. We believe that improving travel-centric services may be considered as an excellent test case of digital transformation changing user activities for their greater interaction and collaboration [5].

II. Project Vision

With respect to a number of scenarios addressed by travel-centric systems [6], the focus of this work is on improving guiding tools providing multimedia assistance automation with a particular attention to audio guiding systems. In contrast to text and image based applications, audio guides have some important advantages. They do not draw attention much away from an object of interest, since the user needs interacting with a screen only in between times. For the same reason (less screen usage) such solutions are more energy efficient, since they drain mobile batteries less.

The objective of our work is to develop an approach to multimedia assistance of outdoor travel tours with using geo-positioning for tour recommendation and playback automation. Unlike to many existing on-demand audio guides created for using in a particular museum or sightseeing site, our idea is to develop a framework that would allow tour creators and tour user to collaborate indirectly.

III. State-of-the-Art Solutions

In contrast to our previous work [7], within the scope of this contribution we pay particular attention to the solutions integrated with geographical maps and providing facilities to define a tour as a route connecting selected POIs with associated audio tracks and other relevant annotations. There is a number of good examples of such solutions including such popular applications as *Izi.travel*[1], *PocketGuide*[2], and *Azbo*[3].

A. Story Telling Platform: Izi.travel

The *Izi.Travel* application is marketed as a storyteller platform for indoor and outdoor audioguiding with a possibility to display other multimedia data such as texts, links or images. Audio track playback starts automatically as soon as a user enters a so called trigger zone (as Figure 1 (left) shows). There is a free walking mode, and a user may select stories from the story base. The application supports both online audio streaming and offline playback of the downloaded tours.

We can particularly mention the following strong points of this application:

- Despite the application recommends to follow a desired order of POIs, the tours are more or less flexible: it is not prohibited to visit POIs in user's own order.
- There are useful features supporting tour timing and distance.
- Registered tour creators use a special interface and an access to the content management system for uploading their own tours.
- There is a sandbox mode: in order to test a just defined tour, the system allows giving an access to this tour only to a limited number of users.
- There is a feature for nearby object recommendations which is particularly important for a free walking mode.

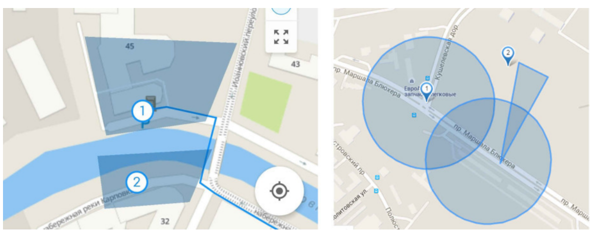

Fig. 1. Visibility area usage (left) and definition (right) in *Izi.Travel*

Thus, there are significant strong points. However, there are issues to consider while improving possible use cases and underlying data models:

- Since trigger zone definition is a tour creator's responsibility, there could be inconsistent zones (as Figure 1 (right) shows). As a result, audio track playback might not always begin in the most appropriate moment.
- Audio playback begins from scratch if a user quits a trigger zone for a while and enters it again. In such a case the user has to adjust the playback manually.
- Nearby object recommendation facility doesn't differentiate users according their movement speed (recommendations would be more helpful if we would able to distinguish between walkers, biker and car drivers.
- Audio tracks are played by the application itself, not in background.

B. Travelling in Big Cities: PocketGuide

The *PocketGuide* application is oriented to those users who travel in big cities. Basically, the audioguide collection contains numerous must-see style tours featured with the access to information about dining and shopping facilities displayed on the map. Such approach is particularly suitable for business visitors having not much time for detailed tours and for prior preparations. User can create travel diaries and sync them with user's *Facebook* account). The *PocketGuide* provides also a ticketing platform for the partner companies selling regular (non-electronic) tours. A user can sync audio with others (a certain fee required) but we did not find any possibility for creating and sharing user's own routes. Thus, the *PocketGuide* is rather a consumer-centric (not creator-centric) platform.

Summarizing obvious advantages of this application, we can emphasize the following important points:

- For each tour there is information about its distance and required time; for some tours the best and the worst visiting time periods are provided.
- It is possible to download the offered tours for the selected city all-at-once.
- By using device orientation and geo-positioning, the application computes the current user's field of vision automatically.
- The application provides public transportation information for accessing the POIs.
- There are tours offered in many languages, and the application provides a convenient interface for selecting a tour in your language.

There are some issues which are not completely resolved in the *PocketGuide* and provide foundation for future work:

- Tours are classified only by cities.
- The application straightforwardly follows the model "see the most in the shortest time". However, though information about tour distance and required time is available, a user is unable to search a tour for a given period of time.
- Despite significant efforts to compute a user's field of vision, sometimes playback begins even if an object is overlapped by another objects.
- Similar to *Izi.Travel*, the recommended nearby objects might be very distant from the actual user's position.
- It is expected that a user permanently holds a mobile device and interacts with it. All the information (where to go, which object is worth looking at, etc.) is shown on the screen. So, the application is rather not much battery-friendly: it exploits very actively the most energy consuming device features (such as screen, GPS, wi-fi, positioning sensors, etc.)

[1] https://izi.travel/en
[2] http://pocketguideapp.com
[3] https://azboguide.com/en

- Tour search and classification facilities are very limited.
- No platform for tour creators is provided: the standard option is to contact the *PocketGuide* team.

C. Up to a City District: Azbo

In the *Azbo* guiding application the available audioguides are classified by cities and city districts. In contrast to the *PocketGuide* and the *Izi.Travel*, a user selects and launches the audio tracks manually. For the cities included to the *Azbo* list, there is a possibility to create a new tour; however, a tour creator is limited by only those points which already exist on the *Azbo* map (this feature requires user authorization). Local user itinerary construction is possible with using points defined in the system.

Among other significant advantages we could mention the following capabilities:

- The *Azbo* supports tour search by a desired time and duration.
- There is a nearby excursion searcher (it this mode, the tours can be offered in 1 km area close to the actual user position).
- All the itineraries available for a certain city district can be downloaded. Available district itineraries are shown on the map. This simplifies tour selection.
- Registration is required only for new public itinerary creation.

There are several drawbacks which could be a rationale for further improvements:

- Currently the *Azbo* does not support automated audio display. Apparently, a user has to permanently hold a device in his or her hands.
- We did not find an option to create a tour in a city which is currently not included to the *Azbo* list. We think that it could stand in the way of gaining more popularity among those users who would like to share their own experience in new places.
- User itineraries are saved only to a mobile device. The only way to create your tours is to use the mobile application. There is no any platform for tour creators and for collaboration of travellers.
- The route between the existing points is created automatically. In reality, such an automatically constructed route might be far from being optimal, especially if the goal is not to construct the shortest route, but to offer the most interesting connection from creator's point of view.
- Excursion online streaming is not supported. Every excursion has to be downloaded to a user device.

D. Lessons Learned

We admit that developers of the above examined applications had their own views on the features they decided to implement. So, it is extremely important to note that our analysis **does not tend to criticize existing solutions** (which are excellent examples of very successful and popular products), **but to summarize possible areas where concepts, data models, use cases and application organization can be rethought, improved or advanced**.

In particular, our investigations showed that most existing applications are limited on selecting a tour to follow: there is no support for postponed or suspended tours; there are few features allowing tour adjustments or recommendations according traveler's movements.

Many applications target the travelers who did preliminary preparations, so such travelers (more or less) know the places that they would like to visit. However, there are situations when the primary plans of a journey are not connected to sightseeing (for example, in a case of business trips). In such a case, there could be spontaneous walks within the limited period of time: it means that a traveler might not have time and/or wish to carefully select the possible tours. The same situation might happen if a traveler has to overstay in some area due to such reasons as flight delay, missing the train, business program extension, etc.

Current systems have very limited support for tour combinations and/or for using fragments from different tours during one walk without forcing users to explicitly select these fragments.

Attempts to define traveler's field of vision automatically requires using device orientation facilities. Thus, a user has to constantly hold the device in hands in proper orientation: in such a way, the user has to interact with a device instead of directing attention to the tourist attractions. Most interactions with a user require screen operations. Again, it does not help in focusing user's attention on the excursion, not on the device. Furthermore, an active screen might quickly drain device battery.

We also believe that it is very important to combine online streaming facilities with the support for following the tours when the user device is not connected to the Internet.

IV. Interactive Audio Guiding System: Object Model and Interfaces

Our focus is on creating flexible tours with paying attention to actual traveler walk using geolocation and other features of mobile devices.

We define two major *user roles*: a tour creator (*expert*) and a tour user (*traveler*). Hereafter we describe the object model of interactive audioguiding system.

A. Object Model

A *tour* is a sequence of *point of interest*s (POIs) where for each point a *zone of vision* is defined. A zone of vision (which is also a trigger zone used to decide at what moment the corresponding audio track playback should start) is a geometric shape corresponding to a certain area associated to a geographic map. Trigger zone definition is based on polygon geometry types from "OGC Simple Features Specification for SQL OpenGIS" [8].

A set of entities (POI, POI zone of vision, POI multimedia) forms a *standard location model*. Location multimedia may include audio tracks (particularly, for a case of creating tours based on audio guides), photos, as well as links to various external resources.

We also define an *advanced location model*, which, in contrast to the standard model, is a set of several *points of vision* associated with the location (optional). Every point of vision is defined as a sub-area inside the location's zone of vision, and includes a particular multimedia track (e.g. audio track), a set of images, a text annotation and its zone of vision. Points of vision do not force users to follow some fixed routes between them; possible traveler's ways between these points are free: each point of vision represents an independent description of the corresponding POI inside the location. A *tour model* includes one or several standard or advanced location models. Within one tour model, zones of vision associated with different locations (as well as with point of vision's trigger zones) should not interfere (this is a tour creator's responsibility) with each other. Major entities of the core object model are shown in Figure 2.

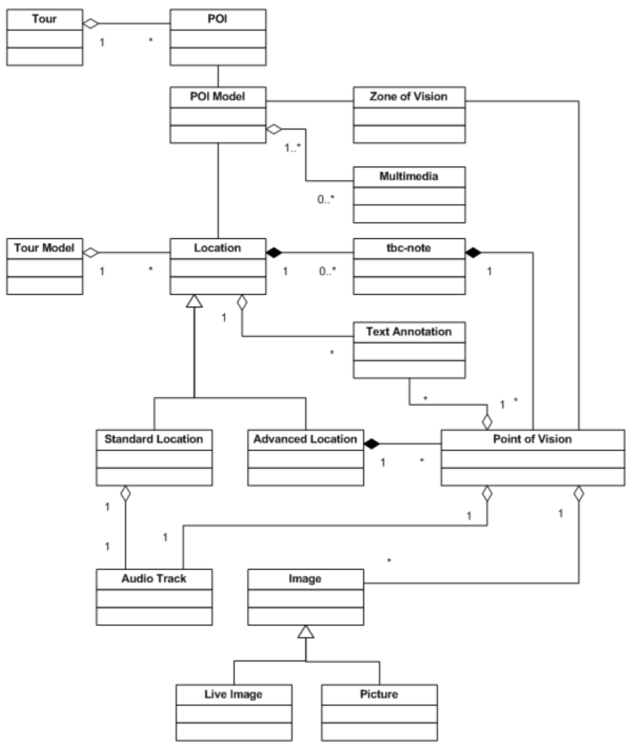

Fig. 2. Interactive guiding system: object model

A guide interacts with a system by using two kinds of client software. A tour may be created interactively using a mobile application. However, many things are hard to define "on the way" only by using a mobile client: so a web-based interface is required as well. That is why both a location and a point of vision might require supporting *tbc-notes* ("to be completed" notes). Due to such notes, an expert is able to introduce a deferred action which is an action to be completed later, or/and with using a different client. If the note is marked "to be completed", such a note, depending on expert's decision, might block a certain location or point of vision from being included to a tour description to be delivered to end users. Possible tbc-notes might include hints to add an audio (or multimedia) track, to add an image, to compose a detailed description, to find reference information, etc.

In contrast to a tour model, an actual traveler's route might of course differ from a proposed model: the traveler might stop in some interesting POI (from his/her point of view) while passing others by. Thus, the information system should be able to follow possible deviations from the route and to suggest possible ways to continue a tour with using information created by experts.

A traveler is unable to modify an original tour model created by an expert, but a traveler is able to add some annotations that could be useful for other travelers. An example of such information is POI (or point of vision) accessibility or availability in a concrete moment of time. The point of vision model may be extended by using a set of additional constraints:

- Date range;
- Time range within 24 hours;
- Weekdays; and
- Weather conditions (for example, according to *openweathermap* [4])

Some constraints may be used for both standard and advanced location models. A set of constraints related to a point of vision is a logical subset of constraints defined for the corresponding location model.

In process of following a tour by a traveler, the system collects information about passed points geo-coordinates and their specific parameters – point weights. Point wights are introduced for taking into account such parameters as geo-coordinates accuracy, the fact of playing a track when this point is registered, device geo-coordinates sampling time, etc. Such data are not associated with a user, but with a location model. Thus, they provide support for getting statistical information about the location visited by different travelers (e.g. about visiting intensity). Such information might be useful both for other travelers and for tour creators (in the latter case, we would have a sort of feedback about in which way and how often the travelers follow the proposed itineraries).

B. Usage modes

We define two basic modes: *just walk* and *single guide play*. In the just walk mode, the system suggests the possible guides based on traveler's current position. We also consider an option to take into consideration traveler's preferences (remaining time, themes, etc.)

In the single guide mode, the selected tour (either in the beginning of a journey, or after following a suggestion in the just walk mode) is played. We consider two basic playback modes: a *standard playback mode* and an *interactive playback mode*. In the standard mode, playback begins as soon as a traveler enters the location zone of vision, and ends when the traveler leaves this zone. In the interactive mode, at the moment when a traveler enters the location zone of vision,

[4]https://openweathermap.org/weather-conditions

the traveler gets a notification. The traveler is able to see all the points of vision on the map and their areas of vision. As soon as the traveler enters such an area, playback begins for a certain point of vision.

One of objectives of our approach is to extend the standard audio guide organization with the abilities to create and modify tours with using information of current guide or traveler position and with respect to such device features as geo-positioning, photo/video camera, voice recorder, etc.

C. Databases

In accordance to the object model and the usage modes described in Sections IV-A and IV-B, we designed the server-side and client-side databases. Figures 3 and 4 represent the excerpts with only core database entities included. These core entities are required in order to examine synchronization issues discussed in Section IV-D. Database schema was designed with *dbdesigner.net* [9].

D. Synchronization Issues

With respect to indirect collaboration of tour creators and tour users, the important aspect is how to sync tour contents in the case when a tour is modified by a tour creator or by an authorized moderator. If the tour is currently playing, its modification on the fly might unpleasantly interrupt the excursion: it is highly unlikely that users would be satisfied with such an interruption. So we propose the following algorithm in order to assure proper synchronization of client device contents with the changes on the server:

1) As soon as an expert decides to modify a tour, and saves the changes in the mobile or web client application, all the update information is sent to the server by using PUT (for a tour update operation) or DELETE (for a tour removal operation) method [5].
2) On the server side, the records corresponding to the tour (to be modified) are deleted together with all the records from the linked tables (places, translations, etc.) as well as from the tables containing user modified data (such as accessibility marks and passed points information). After deletion, on update, the new tour record is added to the database.
3) On successful server database modification, PUSH-notifications are sent to all the users. Every notification contains the following data:
    a) "Operation" – "Update" or "Delete";
    b) "Outdated tour id" – a removed tour id; and
    c) "City of outdated tour" – a city id.
4) As soon as a client device gets the notification, the application checks whether a tour exists in the local database. If such a tour exists, the application checks whether it is active (being played) right now.
5) If the client is in the single guide mode and the outdated tour is being played, the application changed status of playing tour to "Outdated". This status change prevents from interrupting the tour, but prepares its further update. If the tour is outdated, the application continues playing the tour, but stops sending requests for updating user-provided information (such as POI accessibility marks, passed points information, etc.). The recent information (i.e. information before the update) stored in the local database is displayed to the user. As soon as a user decides to stop this tour, the tour is completely deleted from the local database. The new version is downloaded upon further selection of this tour.
6) If the client is in the just walk mode (it means that there is no tour which is currently playing), the application checks the update notification parameter "City of outdated tour". If the user is in this city, all the information in device memory (e.g. points on the map) is reloaded again.
7) If currently there is no specific mode, but a user interacts with one of tour information screens, the application suggests to update data. The outdated tours are now blocked for usage.
8) In all other cases, the outdated tours are removed from the device.

Thus, an active tour is not interrupted even if a tour creator modifies it. The application proceeds with an update only if a tour is completed or cancelled by the user. Despite some records might require being downloaded from the database while the tour is playing, this is only a minor synchronization overhead. Finally, the outdated tours are completely deleted from the server database, hence frequent GET requests (required, for example, in just walk mode) do not imply the analysis of many outdated database records.

At the same time, we admit that such an approach is not free from several drawbacks. The above described algorithm is not incremental: partial updates are not possible. So, for example, a tour creator can not change only some location attribute, and update only this small part of data. In such a case, the whole tour has to be updated. The server file system might become obstructed by a lot of outdated information. So, some garbage collection scripts might be periodically required, and this process might temporarily block the system for accessing by mobile clients. In this work we did not consider this issue.

V. Conclusion

Based on our analysis of solutions offered on the digital market, we introduced an approach to developing an audio-guiding recommendation and journey assistance systems with particular attention to system usage scenario definitions, its architecture and data models. In addition to using necessary standard features of present-day mobile devices (such as geolocation sensors and multimedia facilities), our solution follows an idea of implementing a collaboration framework and exploits a concept of mobility in a broader sense: users may complement the contents of a tour they follow, and,

[5] According to the REST (REpresentational State Transfer) architectural style for distributed hypermedia systems [10]. HTTP-based web-service APIs adhering to the REST architectural constraints typically use a set of standard HTTP-methods: GET, PUT, POST, and DELETE. See [11] for details.

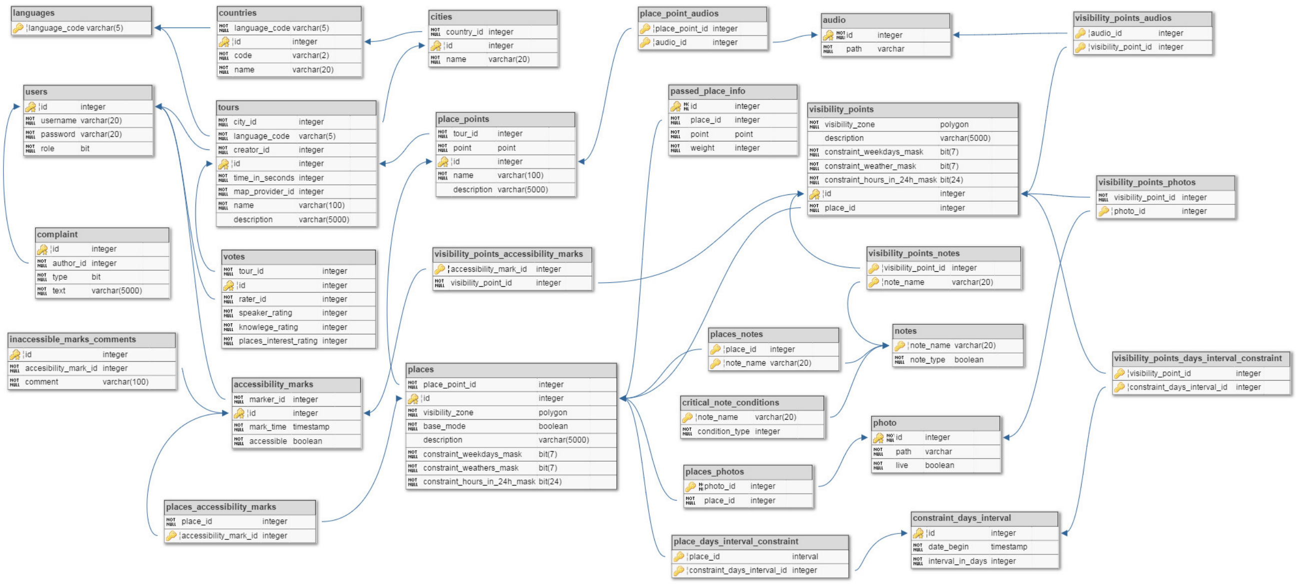

Fig. 3. Server database: core entities

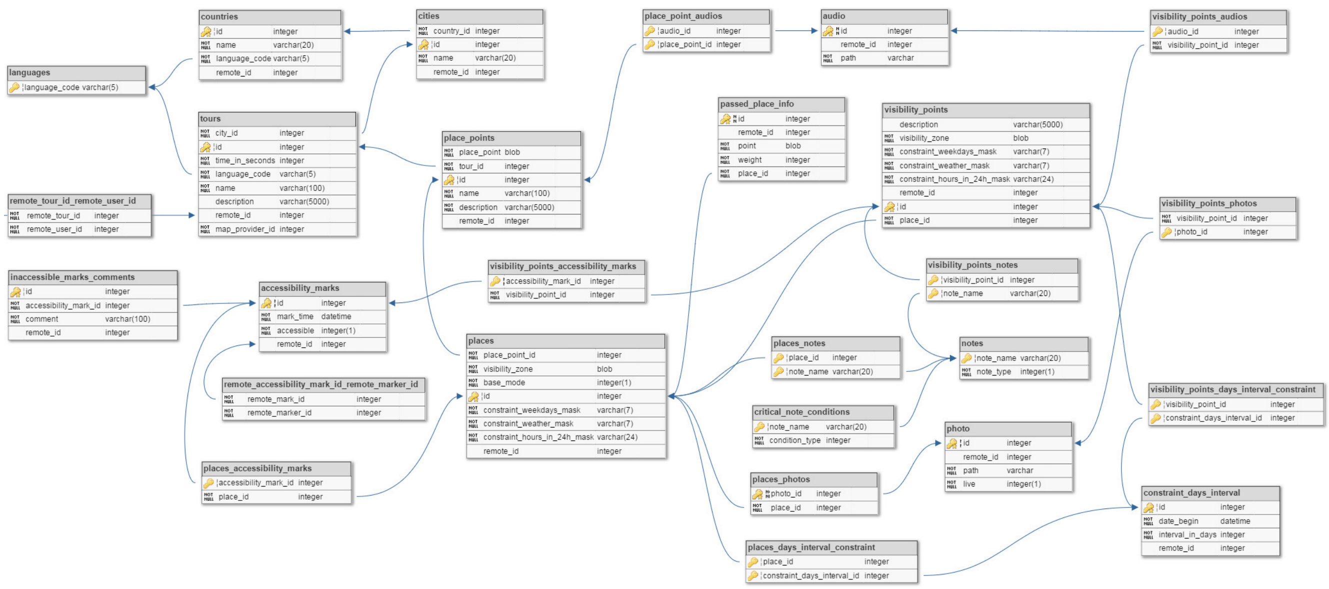

Fig. 4. Client database: core entities

conversely, tour creators can leverage customers' experience while creating or modifying travel tours.

We particularly address a just walk scenario where the system does not force concrete activities upon users, but suggests possible options on the base of available tour information, actual conditions and existing recommendations.

A tour creation model fits both professional guides and (even more) amateurs willing to share their knowledge and experience with others in the form of authored audio excursions integrated with geolocation features and geographical maps accessible from a mobile device (currently we rely on Google Maps as a map service).

We believe that our approach can expand opportunities of present-day audioguiding applications and increase the number of potential stakeholders interested in using such systems. The obverse case is the eventual complexity of tour creator's user interface required in order to support all the capabilities of the proposed architecture. Our future work is on improving user interfaces, increasing the system's flexibility by using a number of different map providers as well as advancing a concept of automated tour and track selection and recommendation.

ACKNOWLEDGMENT

This work is partially supported by the grant 17K00509 of Japan Society for the Promotion of Science (JSPS).

REFERENCES

[1] J.-P. Gerval and Y. Le Ru, "Fusion of multimedia and mobile technology in audioguides for museums and exhibitions," in *Fusion of Smart, Multimedia and Computer Gaming Technologies*. Springer, 2015, pp. 173–205. [Online]. Available: https://doi.org/10.1007/978-3-319-14645-4_8

[2] A. Gionis, T. Lappas, K. Pelechrinis, and E. Terzi, "Customized tour recommendations in urban areas," in *Proceedings of the 7th ACM international conference on Web search and data mining*. ACM, 2014, pp. 313–322. [Online]. Available: https://doi.org/10.1145/2556195.2559893

[3] A. Majid, L. Chen, H. T. Mirza, I. Hussain, and G. Chen, "A system for mining interesting tourist locations and travel sequences from public geo-tagged photos," *Data & Knowledge Engineering*, vol. 95, pp. 66–86, 2015.

[4] O. Patri, K. Singh, A. Panangadan, and V. Prasanna, "Automated planning of leisure walks based on crowd-sourced photographic content," *IEEE ICSC 2015, Anaheim, California, USA*, 2015.

[5] S. J. Berman, "Digital transformation: opportunities to create new business models," *Strategy & Leadership*, vol. 40, no. 2, pp. 16–24, 2012.

[6] E. Pyshkin and M. Pyshkin, "Towards better requirement definition for multimedia travel guiding applications," in *Computational Intelligence (SSCI), 2016 IEEE Symposium Series on*. IEEE, 2016, pp. 1–7. [Online]. Available: https://doi.org/10.1109/SSCI.2016.7850189

[7] E. Pyshkin, A. Baratynskiy, A. Chisler, and B. Skripal, "Information management for travelers: Towards better route and leisure suggestion," in *Computer Science and Information Systems (FedCSIS), 2016 Federated Conference on*, vol. 8. ACSIS, Sept 2016, pp. 429–438. [Online]. Available: http://dx.doi.org/10.15439/2016F224

[8] G. Open, "Consortium: Opengis simple features specification for sql, revision1. 1," *OpenGIS Project Document*, pp. 99–049, 1999.

[9] "Dbdesigner.net: Online database schema designer," accessed: May 7, 2017. [Online]. Available: https://dbdesigner.net/

[10] R. T. Fielding, "Architectural styles and the design of network-based software architectures," Ph.D. dissertation, University of California, Irvine, 2000.

[11] "Restful web services tutorial," accessed: Feb 4, 2017. [Online]. Available: https://www.tutorialspoint.com/restful/index.htm