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TMAP: Trip Recommendation System Accommodating the Mobile Tourist Preferences

Ferdi SONMEZ[1]
Arif Mehmet AKAY[2]

[1]Computer Engineering Department, Istanbul Arel University, Istanbul, Turkey, [1]E-mail: ferdisonmez@arel.edu.tr
[2]Application development Center, Turkcell, Istanbul, Turkey, [2]E-mail: arif_mehmet@hotmail.com

Abstract *Having or making a trip is a very important component of everyday life. With the new technology, the trip recommendation accommodating the mobile tourist preferences possible and has become a new research area. This type of trip recommendation means planning the most appropriate trip route between locations, based on users' preferences. The purpose of this study brings a new solution to trip recommending for travellers to or residents of a place. For this manner, we examined other mobile applications to expose shortcomings and open features and services to be developed. Tmap is a location based application which enables tourists or any local users with a facility to explore and get information about nearby must see places according to his/her personal point of interest. In the application, the main categories are listed as shopping, architecture/parks, museums, natural places, food/drink/fun and historical places. The places were gathered together in each category according to necessities or interests of the user. The optimized route and direction which the applications displays to the user through an interface which was designed in order to fulfill user's requirements and demands in the best possible way.*

Key words Trip recommendation, SQLite, Google Map API, Intellij IDEA, API Guides, Android OS

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1. Introduction

The pace of innovation and improvement on wireless technology is accelerated by market forces. Cheaper, faster and more power-efficient solutions are expeditiously evolving for indoor, and short-range and wide-area wireless communication. Gaining access to the Internet anytime and anywhere through mobile devices is the biggest benefit brought about by mobile internet services such as Wi-Fi and 4G (Meier *et al*., 2014; Krusche and Bruegge, 2014). With the expansion of the smart phone and tablet markets, people can enjoy various services available on the Internet, bringing much convenience to their life. In this point, one of the significant benefits of mobile network and devices is making Location Based Services utilizable in order to make use of the geographical position of the mobile devices for personal purposes of tourists or residents.

Tourists and travellers may confuse about unfamiliar places, since there are a large number of preferences from among choices for consideration (Biuk-Aghai *et al.,* 2008; Najafi *et al.,* 2015). To support information searching and decision making in this domain, mobile recommender systems may be seen as beneficial tools (Biuk-Aghai *et al.,* 2008; Ahn 2008). Mobile search distinct from web search related with the differences between devices and the information needs of the mobile users. Mobile users have an inclination to locate different types of content. Their information needs also contain location-related, temporal and social dependencies (Akenine-Möller and Ström, 2008; Ansari *et al*., 2000). As users being mobile, contexts such as social interactions, activity, time and location change with them and affect their information needs.

Mobile devices provided location information by which people started to use local search services with those. Point of interests (PoI), local services and directions are a few examples of the favorite information requirements of the travellers and residents (Biuk-Aghai *et al*., 2008; Akenine-Möller and Ström, 2008; Ansari *et al.,* 2000; Olsson and Salo, 2011). Mobile local search is not only affected by the context of the mobile user, but also from type of the entities it addresses (Heidari, 2014). Similar to the general mobile search, users have a strong dependency on different types of context, such as activity, time, location and social interactions. For instance, when a user searches for "food", she may prefer a close-by fast-food restaurant in the noon because of time restrictions. If she issues the same query after work, she may prefer a farther dinner restaurant since she probably has more free time. Besides, local businesses and point of interests contain different types of information than web pages. Mobile users issue local queries to learn open hours or driving directions, or read reviews about a particular local business.

Current mobile navigation applications have plenty of features including not only the route information but also other useful information about the surroundings of the users (Olsson and Salo, 2011; Baltrunas *et al.,* 2011; Basu *et al.,* 1998). In most of the today's navigation applications, the provided route information includes traffic congestion, estimated time and distance to a destination, visual representation of the route and directional information. Moreover, most of these applications provide information about the surroundings, which may include textual or visual representation of name or other details of the buildings, avenues, streets, restaurants and all the other places that might be helpful for the user in exploring the environment. Within these two common features, navigation service of these applications is the main motivating reason for the users to decide on using these applications. Therefore, mobile navigation applications are essential for people especially tourists and residents to figure out how to get from one point to another in any environment without risk of being lost (Biuk-Aghai *et al.*, 2008; Ahn, 2008). Although the main reason of preferring these applications is to get navigational services, people also use them to get to know the environment, which they have not been before. Therefore, in the development process of these applications, the main focus should also take the elements of exploration and discovery into account.

In order to increase the value of services supplied by these applications, the user interfaces and interaction styles of these interfaces should be well-designed (Ahn 2008; Baltrunas *et al.*, 2011). Since the mobile navigation applications are mostly used by the users when they are driving or walking, these applications should not demand all of the users' attention, which, otherwise, could cause accidents. Thus, user interfaces should provide simple interaction with the application and require low number of actions for a task, such as, choosing a destination from the menu and following the route. This brings other important factors that should be taken into account in the development process of navigation applications, which are type of user interaction provided by the application and user friendly interface design.

Recommending activities can be useful for not only the tourists or visitors who are new in a new city and do not know which activity and places are good for them, but also to the usual residents of the city who want to discover new places from among many places in the city (Kei *et al.,* 2017). In (Zheng *et al.*, 2016) developed a collaborative algorithm using combined matrix factorization of matrices of different dimensions. Sattari *et al.* (2012) showed that by merging matrices of different dimensions and applying Singular Value Decomposition on the merged matrix. In (Sattari 2013), the idea in (Sattari *et al.*, 2012) is developed further by using both intra-dimensional and inter-dimensional information.

In this study, we developed a trip recommender system, ***Tmap***, which enables mobile users with inexpensive and effortless methods for searching nearby places of interest and attractions. The most important feature of our application provide users with options and shorts ways on the schedule as well as the option of making self-decisions but providing important information. Our application will serve as a guide of the city, personal travel assistant and guide (Kabiri and Malekabadi, 2014). Main purposes of the application are:

- Information about nearby attractions and places to reach them;
- Making users available to create their own itinerary by multiple selection of places offered under different categories;
- Hotels and point to an urgent need in the city (hospitals, pharmacies) or transport;
- Location notification option.

2. Literature review

Navigation systems allow travelers to find their route and explore their surroundings easily and quickly without consuming too much time and energy even they have not visited before (Biuk-Aghai *et al.*, 2008). The terms "navigation" or "wayfinding" can be defined as route planning and moving to a desired destination. People use their stored knowledge and navigational aids to perform a navigation task. Firstly, people try to find out their location and orientation. Secondly, people try to orient themselves to the direction of the destination and plan the route. Lastly, they follow the route to arrive to their destination. In all of these steps, people use their knowledge and abilities together with the navigation aids (Ahn, 2008). The efficiency of this process for the people highly depends on the type and features of the navigation aid. People commonly use paper maps, mobile navigation apps, signposts, and other types of guides for the task of navigation (Bohmer *et al.,* 2010) Apart from wayfinding, these navigation tools can also be used for goal-oriented search tasks, or as exploration task of an area (Braunhofer *et al.,* 2011; Burigat *et al.,* 2008). The degree of satisfaction that a person gets from these navigation tools depends on the usability and capabilities of these tools, all of which have their own advantages and disadvantages for the specific contexts. For instance, paper maps of cities are good in showing the whole city plan with interest points, routes and all the other information at the same time. However, this type of tools cannot calculate the shortest or alternative route to a destination, or suggest something to a user. Moreover, it can also be hard for the people to find a specific place in a crowded map and follow a route. In order to support people in a better way, mobile solutions, which track interactions, use environmental data, and adapt to the present situation, are required (Burke 2000; Burke 2002). In today's mobile technology, mobile navigation applications can track user's physical location and provide navigation service as well as information about user's immediate surroundings as the user changes her location.

These properties of mobile navigation applications create challenges in design and evaluation of these products, which is a highly popular research subject in human-computer interaction area (Blanco-Fernández *et al.,* 2011; Cheverst *et al*., 2000).

There are several types of interfaces among mobile navigation applications. The most popular ones, such as, Google Maps, Apple Maps, Yandex Maps, present information about user location, route, and surroundings through 2D maps. There are also interfaces, which use 3D maps. Additionally, the combination of 2D and 3D maps are also available. Each of these interfaces has been studied in the research area in terms of usability. In (Kim et al 2006), it is claimed that users are confused especially when the route has a complex shape of intersection when using applications with 2D maps interfaces because they provide navigation service with only symbolic representation. In (Rukzio *et al.,* 2009), switching very frequently between the environment and the small mobile phone screen in 2D map interfaces is considered as a disadvantage of this type of interfaces. It is also claimed that the process of associating the information provided by the map with the surrounding world could cause a large cognitive load. Besides these disadvantages, mobile navigation applications that currently dominate the market provide navigation services with a 2D map interface. As an alternative to solve the problems of 2D maps interfaces, augmented reality (AR) technology has been studied in the context of navigation, too (Dey, 2009; Felfernig *et al.,* 2005).

Jeon *et al.,* (2007) developed a semantic web based mobile local search system. When it receives a local search query from a mobile device, it first analyzes the query with the ontology system, and forwards it to a local search system. For instance, a user query "Ataturk Airport hamburger" is analyzed by the search engine and the word "hamburger" is mapped to the category of fast food. Then, a spatial search is applied for the query fast food around the "Istanbul Airport". They report that number of terms in the query is the key factor on the performance of the system.

Church *et al.* (2010) developed a proof-of-concept map based mobile search application, SocialSearchBrowser (SSB) to investigate social aspects of mobile search. SSB tries to address people's information needs, and enhance the mobile search by providing connections to their social networks. It allows mobile users to see queries and interactions of their peers, and issue their own queries. They conducted a live field study with sixteen participants, and generated approximately 300 messages. Afterwards, they complemented the work with a post-study survey to gain insights about participants' experiences. They report that 57% of the messages are location-specific queries, and 36% of the messages are general queries. These queries are answered by both friends of the users, and the SSB server application that retrieves relevant results from third party APIs. Additionally, SSB server also sends an SMS notification to the user when a peer answers a query. They report that participants liked the peer-to-peer answering capabilities and SMS notifications most. They also liked the location-based aspect of the application because it allowed them to learn about location of their friends. They state that SSB served as a tool for both peer-to-peer communication and search while on the go.

Limited input capabilities of mobile devices affect mobile search experience, negatively. Similarly, missing contextual information causes mobile users to have a poorer search experience. To overcome these issues, Arias et al. (2008) developed a thesaurus based semantic context aware auto completion system that can help users in completing the query terms easily, and filtering out non-relevant results based on users' context. They created a thesaurus which represents concepts. These concepts are good candidates to be the most likely-to-be-used query terms for mobile search queries. Additionally, they extended their semantic auto completion engine with context aware recommendation, which filters out irrelevant concepts. For instance, the term 'beach' can be filtered out if a user is not on the seaside, or it is winter. They integrated their proposed model into a working prototype, and tested feasibility of the system with twelve people. They state that all testers found the auto completion system useful and intuitive by reducing the typing time of the query, and making the search system easier to use.

Amin et al. (2009) conducted a web-based diary study on location-based search behavior. They collected 3 types of data: search logs, location data and diary entries. The study was carried on with 12 people for 12 days, and collected 347 location-based mobile search queries. They report that 42.7% and 43.8% of the search queries have been motivated by fact finding and information gathering purposes, respectively. For instance, looking for contact details of a local business is a fact-finding task, and looking for local businesses to decide a place for dinner is an information gathering task. Additionally, they state that 66% of the queries were prompted by activities and situations. Similarly, 76% of the queries were conducted in the presence of others. Lastly, they inform that users choose a local business 23.7% of the time for having a particular product or service, and 15.8% of the time for being recommended by other people.

Ehlen *et al.* (2013) developed a mobile application for tablets and smart phones Speak4it which provides a multimodel interface for users. For instance, a user can say 'hotels' while circling a particular region on the map. Speak4it streams user input and context data to its server. There, it combines the speech and gesture recognition results to evaluate the query issued by the user. The authors intended Speak4it to evaluate user queries in a method such that each new query is independent of context of prior queries. However, they conclude that users often expect the application to take more dialogue context into consideration.

In their study, Jolhe *et al.* (2014) propose an Ontology Based Personalized Mobile Search Engine (OPPMSE) that captures users' interests by mining search results and click through logs. They profile users' interests and personalize search results. The profiles are used to build personalized ranking functions. For instance, a user who is visiting Istanbul may issue the query "restaurant" and click on the search results about restaurants in Istanbul. OBPMSE can learn the users' content preference and location preference, and favor related results accordingly from the click through logs of the user. They also use users' Global Positioning System (GPS) locations to adapt the user mobility in the personalization process and improve the location-related search results.

In addition to the foregoing studies which focus on mobile local search applications, there are various studies that focus on mobile recommendation systems and location-based recommendation systems. In this section, some of those studies are sampled to show the challenges of mobile environments for the recommendation systems. Additionally, there are different approaches and methods in the literature for making recommendations. These approaches and methods are grouped under similar headings. Usually the common intuition in most of them is finding similar users and exploiting this similarity for prediction. These methods are analyzed according to their basic approach, data used, and method. Then, their advantages and disadvantages are compared, as well as the shortcomings and bottlenecks in them.

2.1. Collaborative Filtering

The systems which generate recommendations by using only the rating information are defined as collaborative systems (Cheverst *et al.,* 2000). These systems find peers with similar history to the current user and generate recommendation from them. This selection of similar users is regarded as filtering and interaction of users as collaboration. Hence, this method is called as Collaborative Filtering (CF; Jannach *et al.*, 2004).

The method of collecting user preferences, i.e. rating information, depends on the nature of the applications. They can be collected explicitly or implicitly. Similarly, in a location-based network, number of check-ins may be used as a liking indicator.

Collaborative filtering methods usually suffer from cold start, scalability and sparsity problems (Lee, 2004). In a traditional CF system, there is no offline computation step. This brings the burden that its computation time scales with the number of users or items in the system (Linden et al 2003). A scalable recommender system (RS) should do the expensive calculation step offline and the online phase should not be dependent on the number of total items or users.

In order to overcome this scalability problem, different algorithms are tried in the literature. Matrix factorization methods are used to decrease the dimensionality of the matrices offline. For instance, Singular Value Decomposition (SVD) is used for this purpose. But, these methods first still have a high complexity even for the offline phase, and secondly they cause losing some information in data. There are also some methods such as (Zheng *et al.,* 2010) which try to do this factorization with gradient descent algorithms.

There are also probabilistic models which utilizes probability theory to create relationships between users and items to make recommendations. Since they calculate the probabilities offline, they can be scalable in the online phase.

2.2. Content Based

As described in the previous section, CF systems use only the rating information gathered from users. However, in Content Based (CB) systems, the profile information is also employed for users and other dimensions. Such systems try to recommend items that match the user profile (Lops *et al*., 2011). A basic content-based filtering algorithm make relationship item based correlation between the content of the items without any user dependency (Lops *et al.,* 2011; Borràs *et al*., 2014). It makes suggestions to user by computing the content in a user preference and comparing other items with this preference content. Content-based filtering does not interact a user profile with other users (Borràs *et al.,* 2014). It only correlates with selected user profile and content of other items.

2.3. Knowledge-Based

Knowledge-based recommenders are recommenders which suggest products based on a user's needs and preferences (Zhang and Min, 2016). They respond to the user's immediate needs and they do not need retraining when preferences change. Training is done on the knowledge-based instead. The drawback of them is that knowledge base should be constructed very precisely such that users should be able to select their preferences from them (Kuo *et al*., 2010).

2.4. Hybrid Recommenders

In a broad sense, hybrid recommenders are defined as the combination of two different recommender systems to get more accurate results (Tarus *et al*., 2017). In this way, in an area where one RS has shortcomings, the other RS can come to help. It is also possible that this combination can give worse results if the two algorithms are not filling each other's empty blocks. Note that the hybridized systems do not necessarily have to employ different techniques but they may also (Tarus *et al.,* 2017; Kermany, 2017). For instance, two CB recommender systems could work together as well as one CF and CB recommender systems.

2.5. Problems in Recommender Systems

In this sub-section, some of the usual problems and issues of recommender systems are mentioned. Cold start is defined as the need for having a large amount of data on a user to make accurate recommendations (Kim *et al*., 2006). This is normal since CF systems do not take user profile into account. This problem is also valid for other methods such as CB and Hybrid but since other information are taken into account as well, it is lighter. Still, for many recommender systems it is not very accurate to make recommendation before knowing the user's behaviours (Tarus *et al*., 2017; Kenteris *et al.,* 2010).

Scalability problem is defined as the memory and run-time requirement for running the recommendation algorithms. This is a critical problem in systems with millions, sometimes even billions, of users (Kermany, 2017; Kenteris *et al*., 2010). Scalability is important in both the online and offline phases of the recommender systems. That is preprocessing of the data set should be computationally reasonable to complete in industrially acceptable time and efficiency of the online phase which will be active on user query time should be quick enough not to keep users waiting for the recommendation results.

Most people seek out locals for the best things to see and do in their outdoor activities (Kenteris *et al.,* 2011). Apart from that, what makes a trip or an activity meaningful is what is learned about visited places such as back stories or any interesting information concerned them. However, to reach these information, traveler should generally either find a tour guide or do an excessive internet research. Tmap is planned as a personal trip assistant for any user who wants to enjoy his/her journey as much as possible.

3. Architecture and Design

The proposed method is robust and suitable for very big data sets. The purpose of this application is to bring solutions to our problem by examining other mobile applications to expose shortcomings and open features and services to be developed. In this work, content based approach is followed which is also suitable for large data sets. Tmap will be used as a customizable trip advisor when visiting a new city, or even exploring a familiar one. A user can use the application as follows:

- To reach the locations of nearby must see touristic places and information about them.
- To form her own trip route by selecting places from particular categories.
- To spot hotels, and available built-in city orienteering tracks.
- To check-in their location through app.
- To save route history.

3.1. Software Requirements for Implementation

Java is native programming language for Android OS. In purpose of building, testing and debugging, INTELLIJ Idea IDE (Integrated Development Environment) with Android SDK (Software Development Kit) is used (Kenteris *et al*., 2011). The Android SDK is a set of development tools used to develop applications for Android platform. An IDE is a programming environment that is designed to make computer software easier to develop, and that helps developers to develop software more easily and effectively by offering a number of useful tools to the developer during the software development phase. In order to integrate map features to application, Google Maps Android API (Application Program Interface) is used together with related APIs such as Location APIs and Places API. Software design/architecture of Tmap includes previously mentioned features. Details are described in the following sections.

3.1.1. Non-Functional Requirements

Usability

Usability may include the kind of perceptual and emotional aspects related with the user experience. Usability criteria may be used to evaluate features of user experience (Kenteris *et al.,* 2010; Kenteris *et al.,* 2011; Iwata *et al.,* 2011). Any feedback from the users during or after the development process of an application carries significance since it determines user acceptance, user experience and the quality of the product (Kenteris *et al.,* 2010; Iwata *et al.,* 2011). Without the need for any component other than wireless technologies in terms of usability, all users can run application through internet settings and using the internet of the smart phone. Satisfying user experience has become the intention in the design of interactive systems; hence, the effort in Tmap has focused in removing usability and functionality problems in order to eliminate all possible negative factors to provide positive user satisfaction that exceeds users' expectations (Kenteris *et al.,* 2011). By the way, The Tmap application can be accessed anywhere and anytime in the internet.

Innovation

Tmap provides users the option to choose the route. Applications used by travel guide where space as well as the general characteristics of the route options, users as they can choose the optimized route will be presented to the user as an innovative feature can create their own routes.

Effect

General user interest and the city listed under six different categories determined according to the needs of important historical or popular with Tmap that users will bring is suitable to be adopted quickly by users with additional and innovative features included as different from others and to be used in an active way.

Applicability

In determining the place to be seen while traveling or crawl may be needed to use the mobile application is the most reliable and inexpensive solution provided by Tmap.

3.2. Application Features

The application features of Tmap are as follows:

- The map located on the main screen will display nearby categorized places which their indicators have different colors.
- The user can zoom out to see more places or zoom in to focus on a specific area.
- When the user goes to nearby places tab, she will encounter with a category list which contains places according to their subjects. Places will be categorized in these titles: Historical, Food-Drink-Fun, Art & Museum, Natural Beauty, Shopping, and Architecture.
- When user selects a specific category, application will display a list of nearby places pertaining to this subject with their user ratings and brief information about the place. The list can be sorted according to either user rating or distance.

The user can add her desired places to selected places tab by choosing different places from the lists belonging to specified categories in nearby places tab.

3.4. System Architecture

Tmap is planned and designed as a context-aware mobile recommender system. The tools and libraries that contributed to the implementation of our application:

Java: Java is an open source and high level programming language that is developed by Java Sun Microsystems. Its libraries that are called as Java APIs provide users with support of disc, graphics, network and database. Free java libraries and debugging tools were obtained by the Internet.

Android Developer Tools (ADT): Android Developer Tools consist of libraries, debugging tools, and simulation tools that are used in order to develop any android application. These libraries and tools were obtained by the Internet since it is free.

Intellij IDEA 13.1: IntelliJ IDEA is an integrated development environment (IDE) for developing computer software in Java. Developed by JetBrains (officially called IntelliJ). There is both a Community edition and an Ultimate edition available under the Apache 2 license. Both can be used for commercial purposes. We used the free “Community Edition” of IDEA.

Google Maps, GeoLocation ve PlacesAPI’s: In the implementation of the maps, calculating the distances, creating the route, and determining the locations, we used Google map API version 2 with its related APIs such as Geolocation API or Places API.

For the implementation of the application, three layered architecture has been used. Determined tiers are illustrated below.

3.4.1. User Interface

This layer provides user to interact with the system. For providing guidance to a user during navigation, there should be different interface components presenting necessary information, such as route information, time and distance information (Kenteris *et al.,* 2011; Gavalas and Kenteris. 2011). Mobile location-related information accessing applications are usually arranged by utilizing a consolidation of a map component in accordance with the physical place of user, a list component which may rank descriptive objects, and a few other components (Kenteris *et al.,* 2010; Kenteris *et al.,* 2011; Gavalas and Kenteris, 2011). Maps are effective tools for presenting information supported with spatial knowledge such as nearbay places, local businesses and navigating between those objects. Therefore, it is very reasonable to combine map components with textual components such as lists and filters to display spatial information. Meier *et al.* stated that well known location related information gathering applications pursue this approach (Iwata et al 2011). Correspondingly, a similar approach is followed and a UI using map and listing components is developed. The graphical design of the system is realized here.

UIManager (User Interface Manager): User interfaces should provide simple interaction with the application and require low number of actions for a task, such as, choosing a destination from the menu and following the route (Iwata *et al.,* 2011). This class is responsible for the display of the GUI elements and their functions. The user interface manager (UIM) APIs handle various aspects of the user interface, allowing the applications to display help, command line window, convert date and time formats, control keyboard buffering, display screens and pop-up windows, and to build screens. A user can display inference results and update the knowledge base and location information through user interface manager. Map manager keeps association rules and information on locations. These APIs allow an application developer to manipulate the user interface. These APIs are used in combination with variables, lists, and panel definitions in a panel group object.

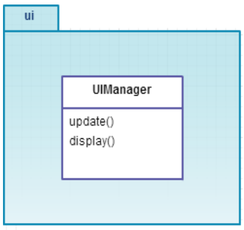

Figure 1. User Interface Manager

3.4.2. Application

The logical operations of the system are realized in this layer with such applications:

• *MapManager:* The most popular navigation applications provide navigation services by using 2D digital map and have common user interactions such as rotating, tilting, zooming, and viewing the map by tapping, dragging, pinching and many other gestures. For *Tmap application, the* goal of MapManager is to display maps, the construction of the places on the map to the corresponding location and map settings such as zooming in/out (Figure 2).

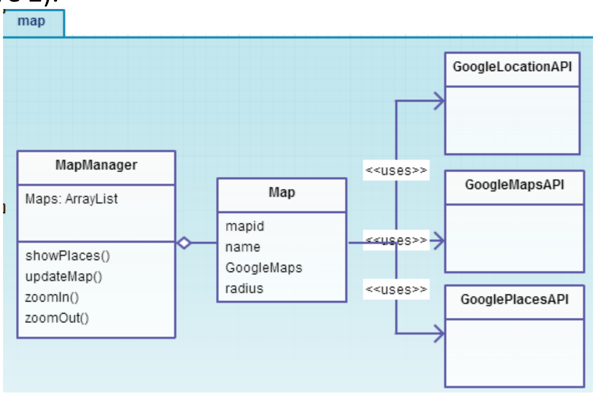

Figure 2. Map Manager

• *TmapManager:* The goal of TmapManager is to store refined information on locations into a database. Moreover, this manager performs all control processes of the system (Figure 3).

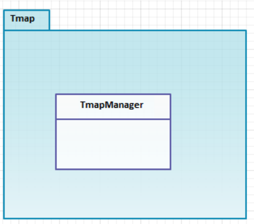

Figure 3. Tmap Manager

- *RouteManager:* The goal of Route Manager is to show user the shortest route and specify destination along with duration either by using car or by walking. In addition, it gives some extra information and signs to navigate users well. This manager is responsible for creation, deletion, back-up and displaying of the routes (Figure 4). Therefore it will draw the shortest route and other information as it done for selecting existing options.

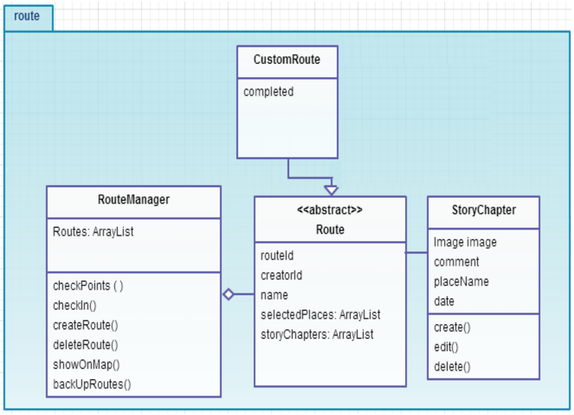

Figure 4. Route Manager

3.4.3. Database

Recommender systems help people to discover or find out suitable places, routes and destinations with large databases of items (Iwata *et al.,* 2011). Tmap Database layer leads system to reach to the saved information in the system (Figure 5). A Database is a container and a namespace for documents, a scope for queries, and the source and target of replication. Databases are represented by the Database class.

Most applications only need one database, but the user can use the Manager to create as many as on her need. Multiple databases are independent of each other. If an application supports switching between multiple users, each with their own separate content and settings, it should be considered using a database for each user.

DBManager (Database Manager): The goal of DBManager is to control the information flow between system and database (Iwata et al 2011). It is primarily used for retrieving and/or modifying information from databases. We have spatial data and ready to use on the map. We need to import, store and keep these data in a database in order to use for the web.

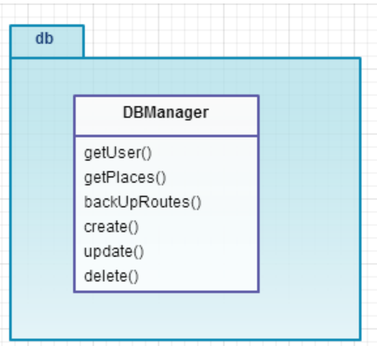

Figure 5. Database Manager

3.5. Object Model

In the object and class model of our application, each can have zero or many routes and each route can have at most 8 places. Moreover, each route will have a story which is a brief analysis about the route. Google Maps JavaScript v3 API is used when creating Maps objects. There is an aggregation relationship among Place, Map and Route objects.

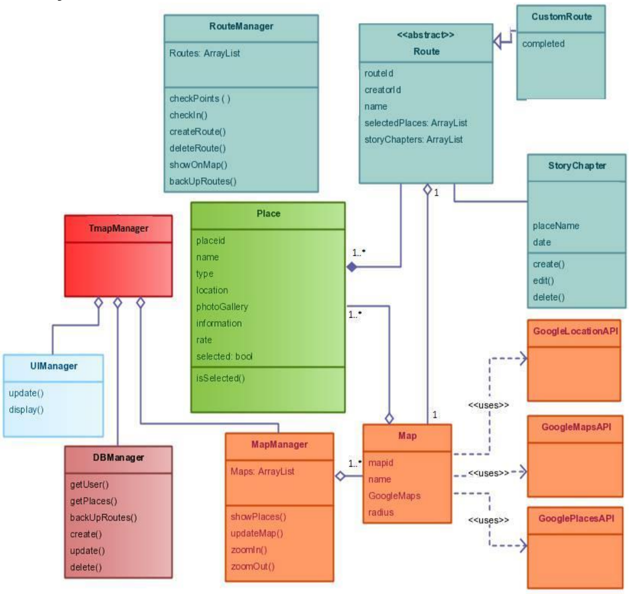

Figure 6. Object Model of the Application

We are going to create a Tmap object acting as a model or value object. MapManager is Data Access Object Interface. Map is concrete class implementing Data Access Object Interface. Data Access Object Pattern is used to separate low level data accessing API (GoogleLoationAPI, GoogleMapsAPI, GooglePlacesAPI).

3.6. Data Management Model

Client side database is implemented by using SQLite database that is already embedded in Android device (Kong *et al.,* 2016). SQLite is an in-process library which implements a serverless, zero-configuration, self-contained, transactional SQL database engine (Kong *et al.,* 2016). As seen in the below figure 7 each entity has unique id as primary key and there are 5 relations. User sends current location (longitude and latitude) and according to his/her location, nearby places are placed in android device within certain range.

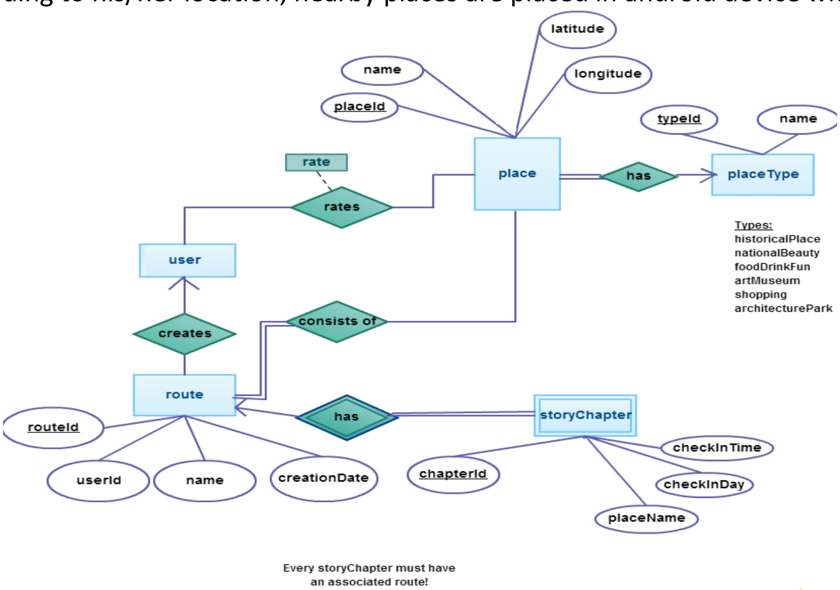

Figure 7. Overall Entity Relationship(ER) Diagram

4. Application GUI

When the user open the application, s/he is directed to the main page that displays the nearby point of interest locations identified at the database by specifying their types with different colored markers. On the map, the star shaped marker represents the user according to his/her real time location. Through this page, user can pass between the pages “near places”, “selections” and “my routes” by using tab menu as illustrated in the Figure 8.

Figure 8. Nearby Places Map Zoom in/out (Main page)

Figure 9. Nearby Places in List Version according to their corresponding categories

In order to create travel route, a user must complete a basic process which will be explained further lines. If the user does not complete location choices by selecting “Nearby” tab, s/he will face with an empty list in the “Selections” tab. Similarly, if s/he did not create any route before, s/he will encounter with an empty list in “My Routes”tab.

When the user selects the “Nearby” tab, s/he will see the page illustrated in the figure 9. The six different colored buttons stands for six different categories in the application. These are historical places (orange), fun-restaurants-bars (red), modern architecture (blue), art and museums (yellow), natural places (green) and shopping (pink). If the user clicks on one of these buttons, s/he will be directed to a screen as illustrated in the figure 10. In the example scenario, the user wants to see nearby architecture/parks and choose some of these as selected places.

The user can display the selected places that s/he chose beforehand in “Selections” tab as illustrated in Figure 10. S/he can delete some of the places from the list before creating the route. Moreover, two different types of routes are offered that a user can select before s/he create the route: Optimized route and ordered route. S/he can select one of these types by using the switch button that is placed in right side of action bar. In the ordered mode, user can order the places as s/he wants to go first to the last. After all of these arrangements, the user can create the route by using the “Create Route” button at the bottom of the screen as illustrated in the Figure 10.

Moreover, the user can give names to the routes that s/he created and can display these routes in “my routes” screen as seen in the Figure 11. In “my routes” screen, the blue one represents the optimized mode while green one stands for ordered mode. In these pages, user can delete the routes before completed it by using the delete buttons at the right of the every list view item.

If the user wants to display one the routes, s/he should click the image button at the left side of the every list view object in the screen. After that, s/he will encounter with a map screen as illustrated in the figure. The marker that is shaped as a star represents the user by real time location. This location is replaced while the user’s geolocation changes. The rectangle markers on the map represent every nearby location that s/he selected in before process. Moreover, every location is connected with a blue line that is calculated as the most optimized route or shortest path. The user can complete his/her travel by coming around every location in an easy way by pursuing the blue line.

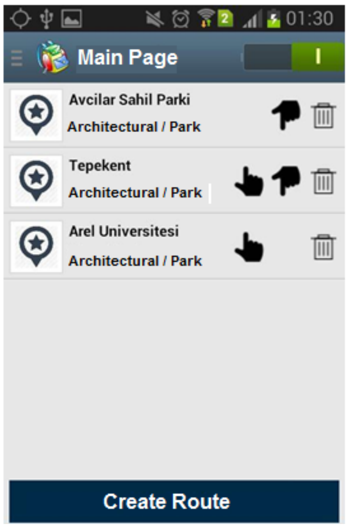

Figure 10. Create Route Screens

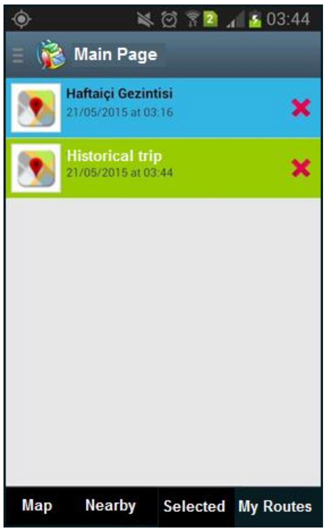

Figure 11. Route List Screen

The user display a list of the locations if s/he is close enough by using the "Check in" button on top of the map screen. If there is no close location around the user (500 m), s/he will encounter with an empty list. S/he can check-in any places if s/he is close enough in the next page that opens when s/he clicks on the listview object belonging to a specific place. After the check-in process completed, the place on the map will be displayed with a black foot marker and will be ignored while calculating the new route. These processes are illustrated in the figures. On the map screen, user can display the names of the places by clicking on its marker. Moreover, after doing that, again by clicking on the name in the information window, s/he can make an automatic Google research (Figure 12). In this way, user can acquire any information about a specific location.

Figure 12. Displaying and searching location

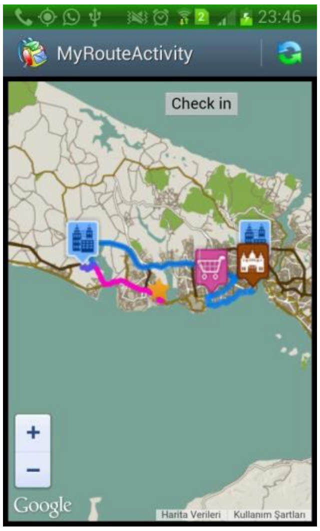

Figure 13. Ordered Mode

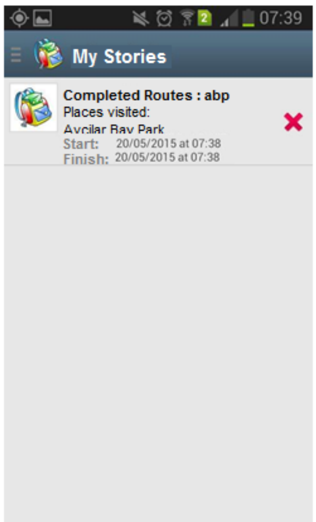

Figure 14. Story Screen

The figures represent a route that created in the ordered (non-optimized) mode as another option. This option can be beneficial when user want go to the places in a specific order. In this mode, the total route will not be optimized; however, the line between every two places will be optimized of course. Therefore, in order to show the first path to the user, or first place that s/he chose. As in the example in the below figures, after s/he checks in the first place the route will directs him/her to the next or second place and so on (Figure 13). After checking in all places, the route will be automatically deleted from "my routes" tab. Moreover, the user will see a dialog fragment in the screen that displays the places that the user have gone through the route and the start and finish dates. Moreover, the user can display this information on "my stories" menu as a travel history (Figure 14). S/he can delete any of his/her travel histories by using the delete button.

Moreover, the user can display nearby hotels (green markers), pharmacies (orange markers), hospitals (red markers), and banks (blue markers) on the map by selecting these sections from main menu. In these map, user can create an optimized route to the selected point by clicking on its marker, display the name of the places, and make a fast Google search. Moreover, s/he can choose the mode of travel.

5. Conclusions

The main aim of this project is to give users a chance to explore the nearby places as well as the new locations according to their interests. It is aimed to design a project which have vivid user interface, easily used by target group and give users limited by qualitative options. The most important options served to users is the construction of route. Rather than similar applications available in market place, Trap offers users a new experience such that users can construct and optimize their own trip routes. The availability and ease of use of mobile phone applications in sake of travelling and many travelling applications available in market place are motivations and driving forces that direct us to think about the design of a project which will be used as a personal travelling guide. Based on this approach, we designed and implemented the whole project and repeatedly debug it to fix bugs and increase the performance and finally our application is ready to use by all tourists or local people.

The system is scalable; open to be made wider, as each guide is for a certain manner. As more projects are documented, scope of the guide will get wider. If done regularly, it could become a complete development guide to whole of trip advisor. Present infrastructure of Tmap system is ready for being used as a content based application. As a future work, we will propose methods which use the information gathered from other users like ratings, remarks and opinions to support the mobile users with attraction recommendation.

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