

INFORMATION SYSTEM FOR URBAN BIKE TRAILS DATA COLLECTION AND ANALYSIS

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Abstract—The shortcoming of modern software tools for processing data about bike trails in the cities of Ukraine are examined in the article. Based on the defined technical requirements analysis of available technologies stack was conducted and the most effective method for creating a system to collect and analyze data on urban bike trails was defined. Also new software solutions to implement improved systems for handling data on city bike trails were proposed. Used technologies: Java EE, Google Maps, Google App Engine service and Google Firebase database.

Index Terms—Java EE, database; Android; Google Firebase; cycling infrastructure; transport planning; data analysis; geodetic data.

I. INTRODUCTION AND PROBLEM STATEMENT

A management of cities around the world trying to promote the use of bicycles for trips around the city because of its low cost, small emissions and high potential benefits in health and social care. Today one of the major air pollutants in urban areas is motor vehicles, emissions from which are 33% of total emissions in Ukraine. Excessive transport also causes traffic jams. One solution to these problems is to use the cycling. However, an implementation of a cycling is difficult because of many constraints in the cities dominated by automobile transport. Such cities need to create a transport system that sensitively responds to the needs of cyclists. Creation of the system in a restricted street topology with limited resources requires accurate information about what compromises cyclists make when choosing their routes. However, due to lack of data, little is known about cycling routes and actual infrastructure used. The strategy of Kyiv development 2025 stated that 10% of trips in Kyiv must be made by bike to the end of its implementation [1].

However, strategy of location of cycling roads in Kyiv is still ill-conceived and requires further improvement. There is an urgent need to develop effective software solution that will collect information about routes used by cyclists in Kyiv. This information should be further analyzed by criteria of convenience and popularity to create the optimal system of easy cycling roads in the city. The system has to build an interactive map of bicycle routes, which it registered, with the ability to sort by different criteria.

The system should provide a public application programming interface (API), through which users can access to statistical data that will help them to

plan their rational cycle route in the city. The system should also provide the possibility to signal about the problems on the roads, such as the poor quality of roads, unauthorized trade or parking on the road.

II. REVIEW FOR COLLECTION AND ANALYSIS OF INFORMATION ABOUT BICYCLE ROUTS

In Ukraine a plan for building the bicycle routes is developing by the analysis of the next factors:

- 1) Greatest transport need:
 - the most number of residents;
 - lack of public rail transport;
 - the smallest number of uphill and downhill roads;
 - the smallest number of delays on the road;
 - optimal length of cycling route (2 –8 km).
- 2) The smallest complexity of realization:
 - lack of complex solutions (road junctions, tunnels, bridges);
 - lower cost of implementation.

The experienced cyclists are attracted to the analysis these factors which provide information about the convenience of one or others bicycle routes. Plan of development of bicycle roads exist only for some cities of Ukraine, including the capital. The main disadvantages of this method:

- it is not automated and is time consuming;
- cyclists personal information is not analyzed;
- optimality and workload of cycling routes depending on the time of day and destination of the trip are not analyzed;
- there is no system of immediate notification of problems existing in cycling infrastructure;
- scheme of the existing bicycle routes is not available on an interactive map.

Cycle Tracks – mobile application for Android and iOS, that passively collects geodetic data about cycle routes, which are then used to counting the cyclists movement in the city planning.

Cycle Tracks uses GPS to record routes and travel time of cyclists, and display maps of all recorded trips (Fig. 1). The application helps to planners of public transport systems to make informed decisions about the use of bicycles in society. At the end of each trip data such as route, date and time are sent to the San Francisco County Transportation Authority (SFCTA) for analysis. All personal data are confidential. The data used to create models that better predict which cyclists will travel and how the quality of roads and transport infrastructure development will affect the popularity of bike in society. GPS data is stored locally on the device during the trip, and only after a trip loaded on the server [2].

Application is written on Python. *Cycle Tracks* loads the data about a trip to the MySQL database on server SFCTA, via the Apache web server and the JSON data exchange format.

The main disadvantages of application:

- the application is not adapted for Ukraine, since it does not have a scheme of bicycle routs of Ukrainian cities;
- does not provide possibility to signal about a problems in the present cycling infrastructure;
- data are not analyzed by time and day of travel.

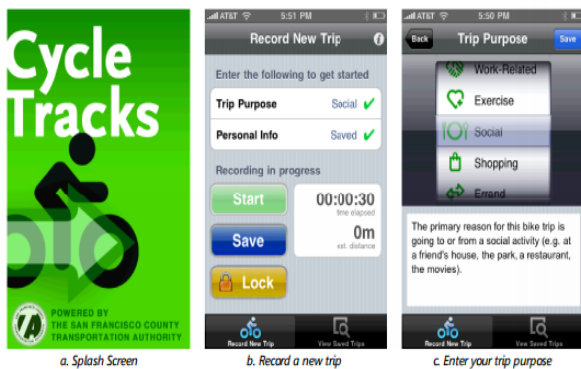


Fig. 1. Graphical user interface of “Cycle Tracks” application [2]

Strava is a website and mobile application to track users sports activities using GPS (Fig. 2). The most popular activities that are tracked by this software is running and biking trips.

Features of the application:

- record your own routes and view other users routes;
- gathering statistics: distance, pace, speed, climb, and calories burned;

- analysis of a heart rate via Bluetooth-sensor Zephyr H×M;
- publication of private photos during training;
- ability to see the popular routes in certain areas on the map;
- making ranking of the most active users.

All the travel GPS-tracks are recorded and displayed on Global HeatMap map (Fig. 3). The database contains 77.000 recorded cycling tracks. At first, the data are divided into areas that are presented by 8 “tiles”. Each of the “tiles” has its own file containing a key / value pair, where the key is pixel zoom key quadrant, and the value is the GPS-coordinates. As a result, there are about 6300 files that are displayed at server startup. When a request comes to the area, the server finds the appropriate descriptor file and performs a binary search for keys.

Since the information for each “tile” is stored in serial access files it can be easily read and two-dimensional array of GPS-points built in each pixel of region [3].

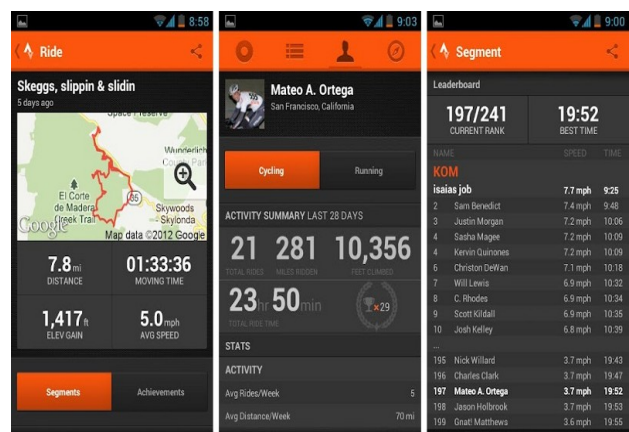


Fig. 2. Graphical user interface of “Strava” application [3]

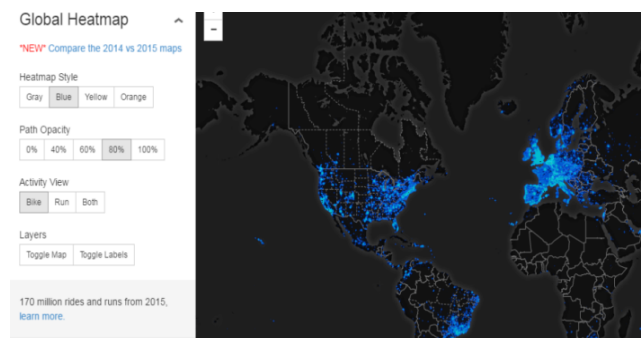


Fig. 3. Global HeatMap of “Strava” application [4]

Application is useful for people who want to analyze and improve their sports performance. The main disadvantages of the program are:

- the application is not adapted for Ukraine and does not contain scheme of Ukrainian city bike routes;

- recorded track of cycling trips cannot be sorted by time, day and destination;
- does not provide possibility to signal about a problems in the present cycling infrastructure.

Google bicycling maps provides a route optimized for cycling, with the identification of bike tracks, bike lanes and roads that is suitable for cycling and avoiding hills whenever it is possible (Fig. 4). The application also provides a rough calculation of the time it takes to travel with taken into account the length of the route, the number of hills during the trip and other variables. Google has partnership relations with Rails-on-Trails Conservancy, a nonprofit organization that creates network routes from former rail tracks, to provide information about biking trails in more than 150 cities [4].

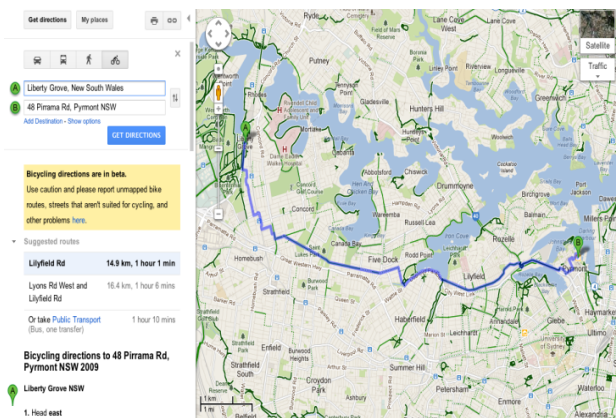


Fig. 4. Graphical user interface of “Google cycling map” application

The main disadvantages of application:

- organization Rails-on-Trails Conservancy does not cooperate with Ukraine, therefore has not data about Ukrainian bicycle routes;
- there is no possibility to signal about the problems on the bike route;
- it is impossible to view a map of all trips realized in certain areas;

- the data is not analyzed.

On the basis of the drawbacks of modern solutions the following requirements for the system that are currently under development were formulated:

- it should reflect the interactive map of current Ukrainian bicycle routes;
- it should permit to display all recorded by users GPS-tracks of bicycle trips with the ability to sort by travel date and destination;
- it should provide statistics of private activity for each user;
- application interface should be clear and easy for users of application.

III. SELECTION OF TECHNOLOGICAL STACK FOR SOFTWARE DEVELOPMENT

As the software will work via the Internet there are such selection criteria and system requirements to the technological stack (a set of technologies used).

- 1) The system must work around the clock and must be reliable.
- 2) System should be placed on the Internet on the servers.
- 3) The system should be accessible from any device which potential users of the system may have.
- 4) The system work on the scheme of universal API for any type of device on back-end side as a software application on Android 4.0 and above.

App Engine platform integrated with other software application and impose some restriction on developers [6]. Environments of parallel processing allow to apply a lot of software developed for Unix-like systems, while App Engine requires developers to use one of the programming languages such as Python, Java, Go or PHP, and to use for storage Google Datastore – specially developed database for this database platform (Fig. 5).

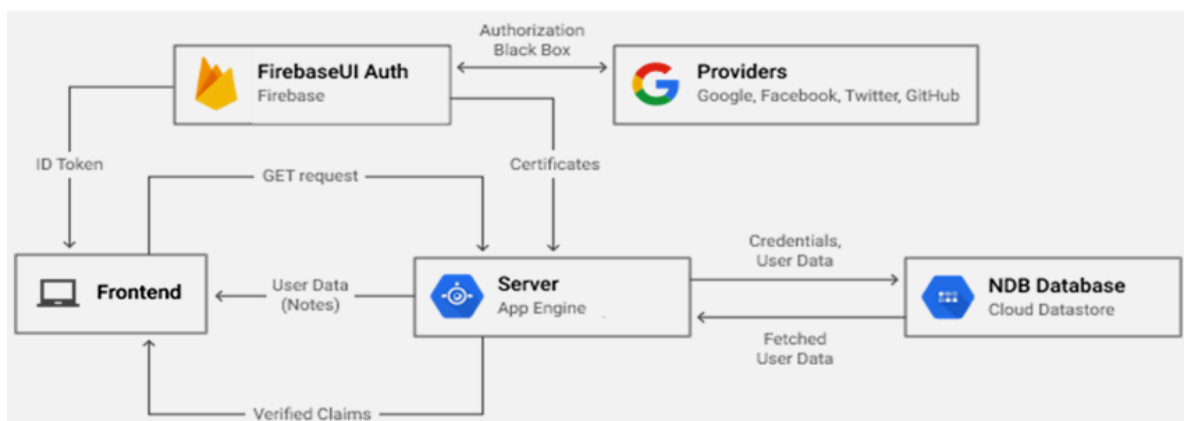


Fig. 5. The scheme of client-server application interaction using the database Firebase [5]

For Java-developers usage of Google App Engine with Google Endpoints API has advantages: allows developer to use Google as a hosting provider and host applications on the Google server; provides server Google App Engine for Java EE applications; allows creating clusters for distributed computing using framework mentioned before; allows creation API for other applications using special annotation classes and methods; provides quick and convenient database Objectify, which is easily and quickly integrated into the software; provides fast and almost unlimited access to the API of other Google products (for example, Google Maps, image recognition technologies etc.); provides quick and easy cash for application.

Database Firebase was selected to store data. It is NoSQL database for real-time application as a service. This service provides an API for developers that let them synchronize data between a customers and store data in the cloud. Developers can also use API provided by Firebase for encryption.

Firebase database has the following advantages: provides a simple hosting for mobile applications; allows developers to customize users registration and authorization; provides the flexibility to customize the front-end (can be customized using HTML, JS); provides extensive opportunities for analysts.

IV. CONCLUSION

The currently existing system of planning and analysis of road cycling in Ukraine does not consider all needs of cyclists. The main advantages of the considered modern software for solving this problem are: ease of working with, providing personal statistics about users activity, a large amount of received data and fast processing. The main disadvantages of the considered software are

the lack of maps marking scheme of cycling roads in cities in Ukraine, the absence of the ability to report about the problems existing in cycling infrastructure and the inability to sort the received GPS-tracks of cycling trips by parameters of day and destination. Based on the studies was defined the requirements to the system being developed and described technology stack for developing Android-application that will be collecting and analyzing information about city bike trails considering existing transport topologies and social characteristics of the region.

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Д. А. Лапчук, Л. М. Олещенко. Інформаційна система збору та аналізу даних про міські веломаршрути
Описано недоліки сучасних програмних засобів для обробки інформації про веломаршрути стосовно міст України. На основі сформульованих технічних вимог проведено аналіз доступних стеків технологій та обрано найбільш ефективний метод для створення системи збору і аналізу даних про міські веломаршрути у місті Київ. Запропоновані нові програмні рішення для реалізації удосконалених систем для обробки даних про міські веломаршрути, які можуть бути використані в містах України. Використано технології JavaEE, сервіс Google Maps та базу даних Google Firebase.

Ключові слова: Java EE; база даних; Android; Google Firebase; велосипедна інфраструктура; транспортне планування; аналіз даних; геодезичні дані.

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Д. А. Лапчук, Л. М. Олещенко. Информационная система сбора и анализа данных о городских веломаршрутах

Описаны недостатки современных программных средств для обработки информации о веломаршрутах по отношению к городам Украины. На основе сформулированных технических требований проведен анализ доступных стеков технологий и избран наиболее эффективный метод для создания системы сбора и анализа данных о городских веломаршрутах в городе Киеве. Предложены новые программные решения для реализации усовершенствованных систем для обработки данных о городских веломаршрутах, которые могут быть использованы в городах Украины. Используются технологии JavaEE, сервис Google Maps и базу данных Google Firebase.

Ключевые слова: Java EE; база данных; Android; Google Firebase; велосипедная инфраструктура; транспортное планирование; анализ данных; геодезические данные.

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