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COMPARISON OF SELECTED METHODS OF INTERACTIVE GEOVISUALIZATION ON THE BASIS OF A MONUMENTS REGISTER IN POLAND

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Summary

Visualization of objects on interactive maps usually completes a design process which is preceded by collecting and processing of data. The same applies to the list of monuments (objects of cultural heritage), as its compilation requires both field and office works.
The aim of the paper was to evaluate if registers monuments maintained by Polish communes (gminas) can be presented with Google Fusion Tables and Leaflet software, the tools that are specifically used to provide and visualize data. Successive stages of creating a communal register of monuments in Poland – from surveying the objects of heritage in the field to preparing their address cards and creating electronic map application – were presented in the paper.
In conclusion, it was proved that a web mapping service, in which text description and photographic documentation of presented objects are complemented with data about their location, can perfectly supplement the communal list of objects of cultural heritage compiled as a standard paper address cards.

Keywords

mashup • data visualization • JavaScript libraries • conservation of monuments

1. Introduction

New computer technologies provide quick and easy access to spatial information which is presented in more and more advanced forms. In recent years, dynamic development of geoinformation web services, also referred to as geospatial services, or spatial data services, is observed. They are usually associated with geo-visualization, understood as the presentation of geographic information on maps [Gaździcki 2012, Sudra 2012, Król and Prus 2016].

The graphic representation of information on maps has a long history. It dates back to the beginnings of thematic cartography, statistical graphics and data visualization, which coexist and complement each other. Digital maps are commonly used by both public administration and private users [Friendly 2008]. They serve to determine the location of objects, to plan routes, to seek for telephone or address data or to explore

virtual space. Increasingly, they take the form of interactive web applications, enrich the form of communication, accompany text information, fulfil not only informative but also marketing and educational functions [Bernat 2015]. The aim of the paper was to compare utility and design possibilities of Google Fusion Tables and Leaflet. Both tools were used to create two model alternative versions of presenting interactive data in the form of monuments register kept by a selected Polish commune.

2. Communal registers of historical monuments

One of legal forms of monuments' protection in Poland is keeping official registers called communal register of monuments by local government authorities.

The way of establishing and keeping a communal list of monuments (in Polish: gminna ewidencja zabytków) in Poland is regulated by the Act of 27 March 2003 about planning and spatial management [Ustawa z dnia 27 marca 2003] and the Protection and Care for Historical Monuments Act of 23 July 2003 [Ustawa z dnia 23 lipca 2003]. Moreover, the entry into force of the Act of 18 March 2010 about the change of the Protection and Care for Historical Monuments Act, as well as the change of some other Acts, have changed fundamentally the character of communal monuments register which became the legal form of their protection [Act 2010, Mikiciuk 2010, Rusin 2014].

According to Act of 23 July,2003 legal protection includes immovable monuments recorded in the register of monuments together with their surroundings and the other immovable monuments situated in the communal register of monuments which should include in particular:

1) monuments entered in the voivodeships' register of monuments,

2) the other immovable monuments situated in the voivodeships' register of monuments,

3) the other immovable monuments specified by a mayor of municipality (city) in agreement with a voivodeship heritage conservator.

A monument is a property or a moveable item, partly or wholly the work of man, that testifies to the previous age or event. The following immovable objects of heritage are especially protected and preserved: cultural landscapes, urban systems, building complexes, pieces of architecture and construction, pieces of fortification, engineering objects, cemeteries, parks, gardens and other forms of designed greenery, places that commemorate historical events, or activity of eminent persons and institutions [Ustawa z dnia 23 lipca 2003].

In Poland, Act of 23 July 2003 is supplemented by the Regulation of Minister of Culture and National Heritage of 26 May 2011 about keeping the register of monuments, national, provincial and communal register of monuments and national register of stolen or illegally exported monuments [Regulacja 2011]. The document defines the scope of information about immovable monuments to be included in an address card in the communal register of monuments. The address card – the Act stipulates – should contain the following data: type identification of a monument's type, its name and loca-

tion, street name, property number and name of a commune and district. The address card can include other information, e.g. a photography, a map fragment with the location of the object and geographical coordinates.

3. Chosen examples of web applications that present a communal register of monuments

A monuments register compiled as an interactive multimedia application can fulfil numerous functions, including informative, educational and marketing ones. It can be made available in various forms, from an application located in a digital data carrier to maps that are components of a web site. However, local government authorities usually present on their web pages communal registers of monuments in a tabular form or as a list in a PDF file. Prepared and provided in such a way, the list does not exploit its marketing potential.

A web application with map functionality, able to present location of monuments, can be prepared from scratch in two ways: in a "static" form based on raster data processing, using selected programming techniques (e.g. JavaScript), or in a dynamic, interactive way based for example on API (Application Programming Interface) tools. In both cases, applications can be extended with diverse multimedia materials including three-dimensional models.

There are numerous techniques and tools available in the Internet which can be used to create a digital equivalent of a standard monuments register. One of the methods involves the programming interface Google Maps API. It was used, to good effect, by Ł. Halik [2011] to create the interactive multimedia web application which presents monuments of Poznań district (Wielkopolska Voivodeship, Poland). This application provides, in a web browser window, information about architectural monuments in four forms: a tabular-text one, a photo gallery, a film and a 3D model. The multimedia equivalent of a communal register of monuments was also proposed by K. Król for Tomice commune (Małopolska Voivodeship, Poland) in the form of an internet site created with the use of jQuery, a popular JavaScript library [Salata et al. 2012]. However, in this application objects cannot be presented on the interactive map. K. Król et al. [2013] tried to demonstrate if a communal register of monuments can be managed by some multimedia applications, including the one called "Communal Register of Monuments" (in Polish: Gminna Ewidencja Zabytków) [Ustawa z dnia 27 marca 2003], system of spatial information QGiS as well as a register in the form of interactive web application.

Digital and multimedia documentation of objects of cultural heritage becomes ever more important in recent years. Kępczyńska-Walczak [2008] analysed the issues related to technological progress in a computer sector and argued for digital recording of archival data. The author also described guidelines on creating complex digital archive and improving cataloguing process, management, protection and popularization of Polish architectural heritage. Standards of description of digital copies documenting monuments' characteristics, with respect to spatial information, were presented by

A. Mościcka [2010]. She claims that spatial information allows to relate monuments to their geographic location and, as a result, to develop a concept of spatial information system for movable monuments, which in turn can be the source of data for an interactive web map.

4. Material and methods

Comparative analysis of usefulness and design capabilities of Google Fusion Tables and Leaflet tools was based on observations made during exploratory tests carried out in the course of preparing two alternative versions of an interactive map of a monuments register encompassing a selected area. The exploratory tests were made on the basis of project objectives and the results of observations were collected in a spreadsheet [Król 2016].

Exploratory testing consists in exploring design possibilities of the application and verification of its functioning. Tests are performed in the following stages: learning, design (concept), performing and reporting. In principle, this technique is used for finding software mistakes, however, in that case, cognitive aspects and usefulness test of the tools, while realizing the specific project, were the primary focus.

4.1. Design concept

Three main design objectives were accepted at the concept stage:

a) modularity – an application should have a map component concevied as a compact set of files (similar in type to a plug-in) or string of characters written in a hypertext document (HTML, CSS, JavaScript),

b) universality – an application has to meet W3C standards (World Wide Web Consortium) and components' structure should be implementable in a structure of any web page of mashup type [Benslimane et al. 2009],

c) responsivity (responsive web design, RWD) – a map component has to be useful regardless of the screen size of the device it is displayed on.

4.2. Field surveys

A model application that presents a register of monuments was prepared for Tomice commune located in southern Poland in Małopolska Voivodeship. The commune is situated by the transport route from Wadowice to Kraków. Environmental values of this area and its location are good for hiking and cycle tourism. Numerous architectural monuments, including temples, roadside shrines and crosses, as well as places of national remembrance, are main tourist attractions of the area [Łopatecki 2011].

Creation of the monuments register was proceeded by field surveys that were to verify information collected by the Voivodeship Heritage Conservator in Kraków. The photographs of objects of heritage, documenting their preservation and the extent of

their transfiguration, were taken on the spot. Spatial registration of objects (in WGS84 system) was carried out using a mobile GPS device – NAUTIZ X7 Handheld (PDA, Personal Digital Assistant), which was also used as a photographic camera and a digital notebook. In total 160 historic objects were catalogued. Each item was described by 13 attributes (including: characteristics and a photo), the values of which became the basis of spatial information system.

4.3. Inside works – creating spatial information system

After taking stock of historical objects, collected data were transformed into spatial information system using QGIS programme. QGIS is a free software (Open Source), developed by its users. Programme allows to create, edit, visualize, analyse, and publish spatial information in various formats [Król et al. 2013]. With its help, the monuments were classified and visualized on the vectorial map of the studied area. Created in such a way, spatial information system was activated in computer network structure of Tomice commune. The acquired data were used to prepare official address cards of monuments which finally took the form of PDF files.

4.4. Project tools characterization – Google Fusion Tables

One of the tools, available free of charge, used to prepare automatically an interactive presentation of data, objects or phenomena, is Google Fusion Tables [Gonzalez et al. 2010, Lee et al. 2014]. It can store data in a cloud (cloud computing) and allows to present on the map points of interest (POI) and other spatial phenomena in the form of polygons or a ranges map.

The resources are made available by Fusion Tables and they can be modified simultaneously by many users and the data cloud can be accessed remotely on Google Drive. This solution is convenient for smaller organizations or private users, as responsibility for IT infrastructure is placed on a service provider.

Google Fusion Tables allows to collect, process, publish and visualize data. The tool uses, among others, tabular data – the basis for map applications, interactive graphs and diagrams can be a table prepared as Excel spreadsheet or Google datasheet. The table can can be compiled directly in the browser window or imported from the prepared file but it should not exceed 250 MB (declared limit of server's space for Fusion Tables account is 1 GB). A data file can be prepared in CSV, TSV, TXT or KML formats too.

Fusion Tables tool does not require the user to have a database server or knowledge of programming languages (e.g. structured query language, SQL) and the software can be operated through graphical user interface (GUI).

Elementary values of the attributes of objects marked on the map with Fusion Tables API (including text description, images and photographs, coordinates, etc.) are imported from an external table placed in the data cloud (the table is identified on the basis of ID key which can be read after logging in Fusion Tables service panel). Fusion Tables API can merge maps with e.g. Google Charts.

The map of objects prepared with Google Fusion Tables can be distributed in three ways: as an URL link (uniform resource locator), in an iframe window (floating frame) or by implementing a fragment of HTML (Hypertext Markup Language) code and JavaScript into the structure of any hypertext document [Król and Szomorova 2015].

4.5. Characteristics of Google Leaflet project tools

Leaflet [2016] is a JavaScript library released in 2011 and written by Vladimir Agafonkin. The software allows to create interactive map applications and is regarded, together with OpenLayers and Google Maps API, as the most popular script library. Its user does not have to possess advanced knowledge on the range of GIS spatial information and coordinate systems, as programming the basic functionalities of the map is relatively easy [Król 2015]. With Leaflet library it is possible to implement interactive maps, rendered smoothly in a browser window, in the structure of a hypertext document, using dozens of "tiles", or maps' fragments. The maps generated in such a way are defined as tiled web maps or slippy maps.

The library is efficient, useful and relatively easy to work with. Moreover, Leaflet is often used in projects of maps for mobile devices [Donohue et al. 2014].

As an open-source software Leaflet is not a property of any map developer and it offers access to various base maps. It is most frequently used with maps created in the OpenStreetMap project because they provide source geographical data free of charge.

5. Process of a map's creation based on Google Fusion Tables

To use Fusion Tables a Google account is required. Setting up map parameters is possible after loading properly prepared data file (data import). This method is recommended for greater number of mapped objects described by a big number of attributes. For less advanced maps, it is enough to create a data table directly, in a browser window, on the Google server.

A data file prepared in CSV format was used in the discussed example. To create it, first, DBF database recorded in spatial information system was transformed into XLS spreadsheet. Next, values of attributes of individual objects recorded in lines were integrated and separated with a slash sign "\". The separator's sign was chosen to make sure that the operation of importing proceeds in a proper way, i.e. that the data table is properly reproduced from CSV file (formatted texts describing specific monuments contained commas and other punctuation marks that could not be used as separators). Moreover, to mark objects on the Google map, their latitude and longitude had to be defined. Fusion Tables automatically identifies the "Latitude" column as the one that contains coordinates of objects on the Google map. The file prepared in such a way was used as a database.

The mapped objects were automatically marked with icons, which were previously defined in an output file by the following categories: a church, a historical building, a chapel, a roadside cross, a gravestone, a natural monument.

Table 1. The part of A HTML/JavaScript code responsible for the Google map menu

```
var legend = document.createElement('div');

legend.id = 'legend';

var content = [];

content.push('<b style="font-size: 14px">Obiekty zabytkowe</b>');

content.push('<div class="format"><div class="color red format"></div><div class="left">Budynki
    </div></div>');

content.push('<div class="format"><div class="color yellow"></div><div class="left">Pomniki
    przyrody</div></div>');

content.push('<div class="format"><div class="color green"></div><div class="left">Kapliczki
    </div></div>');

content.push('<div class="format"><div class="color blue"></div><div class="left">Kościoły
    </div></div>');

content.push('<div class="format"><div class="color purple"></div><div class="left">Nagrobki
    </div></div>');

content.push('<div class="format"><div class="color odt"></div><div class="left">Krzyże</div>
    </div>');

    legend.innerHTML = content.join('');

    legend.index = 1;

    map.controls[google.maps.ControlPosition.RIGHT_BOTTOM].push(legend);
```

Source: authors' study based on Fusion Tables API
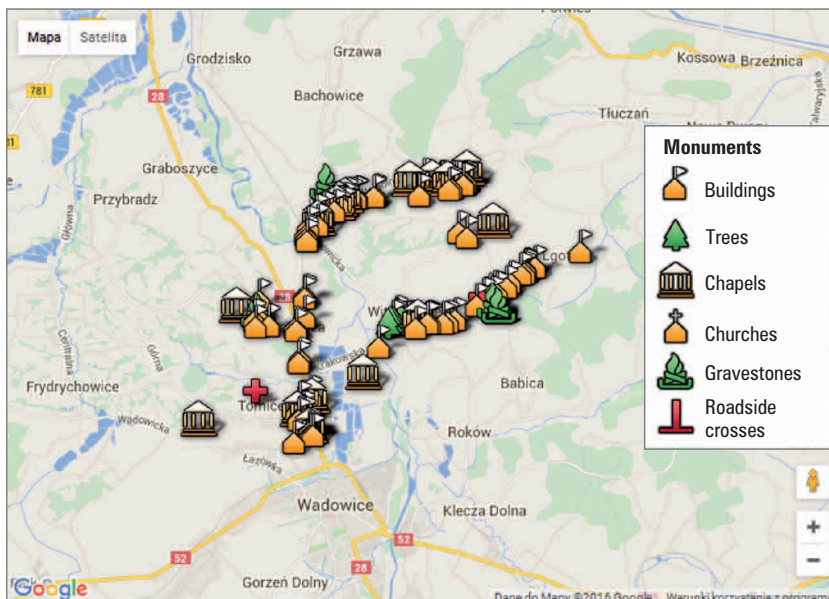
Source: authors' study based on Fusing Tables API

Fig. 1. A fragment of the monuments' map presented in a browser window (a screenshot)

Furthermore, every object was assigned to text information and a photograph presented on demand of a user in the form of a pop-up window. Next, the map was downloaded in prepared HTML/JavaScript code form and transformed by Fusion Tables API thanks to which the map could be supplemented with the legend (Table 1). Using Fusion Tables API in HTML structure and Cascading Style Sheets CSS allows to reshape the format of a map's presentation, and the legend put on the Google map by CSS and graphic files can be modified freely (Figure 1). What is more, when preparing the map of objects, it should be made public by setting appropriate parameters.

6. Creating a map using Leaflet

Maps made available as part of the OpenStreetMap project were selected for the purpose of creating the database of monuments prepared with Leaflet library. The design work was focused on mapping of POI points and defining their layout. Every kind of a mapped point was marked with a separate icon prepared in the form of a PNG file. The icons were linked with text descriptions and graphic sign which characterized an object (Figure 2). In view of the big number and diversity of points, they were grouped and placed in thematic layers which can be turned on and off. Moreover, the menu for changing the kind of a map's base was created to increase its transparency. Programming work was performed directly in a hypertext document, in its structure, implementing individual components of a map including JavaScript libraries and cascading style sheets. Objects' location, description and functionalities were programmed directly in the document which was then placed in the data server.

Source: OpenStreetMap

Fig. 2. The map and interface of application's content management viewed in a web browser window (a screenshot)

The component can then be substantially edited and developed. Each element can be modified. It also meets international standards of creating internet sites which are established by W3C organisation. Taking mentioned features into consideration, it can be quite easily implemented in the structure of any internet site. However, it has some restrictions – it was made with the technique of Hand-Coding Web Pages and placed in a data server. The editing of such a map requires the user to have expert knowledge and access to the server (editing files on a computer hard drive and then overwriting previous ones placed in the server). Implementing the map into the structure of a website managed by the content management system (CMS), which allows to edit content in the browser window, could help solve the problem.

7. Results and conclusions

The design options of the tested tools are similar. These are professional tools internationally recognized and highly useful. The main difference between them is their availability to the average user. Google Fusion Tables is a web application which can be operated by a text menu, a series of buttons, check boxes and drop-down lists grouped in tabs. To some extent it makes the map creation process automatic (Table 2). Although the tool seems to be easy to use, it is technologically advanced, but its operation does not require the user to have any expertise. This is not the case with the Leaflet library. Its user needs to have some knowledge in "programming settings" of a map, which in a sense is created from scratch. Using the API programming interface, a map with specific parameters is implemented in the structure of a hypertext document. These parameters, such as data sources, form and type of objects presented on the map, are programmed using specific commands and programming language which is described in the API documentation. For the average user, this may be the main argument to choose Google Fusion Tables over Leaflet. On the other hand, advanced personalization of a map via Google Fusion Tables can be limited by the application service menu offering its users map settings predefined by the service provider. More advanced changes require knowledge of Fusion Tables API.

Table 2. Comparative analysis of selected functionalities of the tested tools

Specification	Design tool	
	Google Fusion Tables	**Leaflet**
Automation of map's creation	+	–
Using needs expert knowledge	–	+
Form of service	GUI, API	API
Possible mapping of points, linear objects, polygons	+	+
Possible personalization of mapped objects	+	+
Implementation of external data sources	+	+
RWD	+	+

Source: authors' study

Geovisualization of the register of monuments, meeting the adopted design assumptions, can be successfully performed using each of the tools. Final applications in the form of an interactive map of monuments are similar, although they may use different geo-data suppliers and they differ in graphic interface. Interestingly, it is possible to create an application using both tools so that both its versions will vary only in graphic details.

Spatial data services are playing an increasingly important role in the transfer of information. The widespread use of databases and digital cartographic resources becomes possible thanks to growing availability of computer tools and techniques which until recently were reserved to the narrow group of specialised users.

Presented design techniques and tools are selected from many available ones that allow users without any geo-informative background to present data in a web browser window in the form of interactive maps. Knowledge of the basics of programming, especially of HTML, CSS and JavaScript, enables advanced interference in the form in which the map is published and it increases the map's functionality.

A web mapping service in which text description and photographic documentation of presented objects are completed with data about their location can perfectly supplement the standard paper registers of monuments held by local government authorities.

The largest amount of work invested in preparation of an interactive map of monuments is related to cataloguing of objects in the field and the integration of collected data in the system of spatial information. Their transformation and use as the basis for a map application can be regarded as a culmination of design work.

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