INFORMATION TECHNOLOGY SOLUTIONS OF ONLINE MAPSERVERS

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SUMMARY: Operation and structure of various Map hosting websites and databases were examined. Based on my experience, The OpenStreeMap map was selected and used to create the website and geoinformatics database. The completed application can be used in international, multilingual research and helps to collect data on geoinformatics research on fear of crime. The application is currently available in four languages. Stores line and polygon type data in GEOJSON format. Data can be exported in Excel compatible format.
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1. Introduction

During my study, I was asked to further develop an already existing website. The website is used to help the research which measures the fear of crime[1]. My task was to implement, a website to store multiple forms in multiple languages. The study is used to measure the fear of crime, in multiple cities. Each form on the website, consists of a questionnaire and a map. the questionnaire is used to get data from the users, by answers various types of questions. On the map part of a form, the users are able to draw areas, which they deem is either fearful or safe. The green polygon is used to represent the areas which the users feel safe. The red polygon is used, to map the areas, where the users feel unsafe during their daily commute. The white polyline is used, to represent their daily commute path. This paper describe the development of this application and its main features.

OpenStreetMap (OSM)

OpenStreetMap(OSM) (LearnOSM) is a free-to-use editable map data storage, database. The purpose of its creation, is to create a database, that can be used and developed freely. The database was inspired by pages such as Wikipedia. Prior to the creation of OSM, but several other solutions for storing map data have already existed. These databases were not open source, so work on them was limited by strict legal and technical restrictions. Substantial work on closed source maps could only take place under very limited conditions. OSM is open sourced and easy to use database, for mapping purposes. The map, in addition to registration, is available to everyone, and can be freely expanded, retrieved, data from its database.

The map data is entered, using several mapping tools. Users are able to upload their own data to the database. (. By registering on the website available at www.openstreetmap.org, any user can edit the database and add their own data. With the help of the data collected in person or with a GPS device, the data can be uploaded and represented on the website. Currently, the entire database contains around 35GB of data.

There are several software's for the purpose of expanding the database, two of which, I would like to highlight, the web ID and the desktop JOSM. These software's, are specifically editing software's, designed to work on the database.

A simple web editor is available for all registered users. The editor, called ID, allows users to modify the database, with only

internet connection. Using ID, users can create simple points, lines, polygons, multipolygons, and other markups.

A desktop application called „Java OpenStreetMap Editor" was created for modifications of the database. The software is available in several languages, with the help of the software, it is possible to create and edit complex points. Buildings and roads can be mapped and added tot he database. The usage of JOSM is not user friendly, but it does provide the opportunity for precise and complex work of the database.

OpenStreetMap data model

Three major basic element types are used, to store data in the database: Node, Way and Relation. With the help of the three building blocks, the map itself is displayed and all data is made up of these.

Nodes are essential elements of the OSM (LearnOSM) data model. All shapes can be displayed, as a set of breakable points. Each points contains a latitude and a longitude coordinate, and an unique identifier that points to that specific point. All data in the database consists of such nodes.

The connection of at least two points with an ordered label is called a Way in the OSM data model. There are two types of lines, open or closed. An area also known as Polygon, is a line that has a closed line property and its area is filled. The area must be labeled with the tag „Area =yes" for it to be a valid area.

The third important element in the data model is called, the Relation. A Relation, creates a set of relationships, from other elements, that contain a common logical or geographic property in that set. Members may have a role if required, to describe the role they are performing. It also has at least one „type=" tag. This label is used as a logical link among elements.

There are other important elements in the OSM data model called Tags. A label describes a particular property of a particular item. Both fields of a label are in a free text format. With the given texts, specific

property of an element, can be described. Both the key and value fields („key=value") can be used, to describe a freely definable property, for a given item. In reality however, the key-value pair of multiple tags is predefined.

Shapefile file structure[2]

Shapefile (ESRI Shapefile Technical Description) is a file format, used in geinformation systems that stores data from map databases along with their properties. A Shapefile is not referring to a single file, but to a common group of multiple files. This format cannot store topological data. It can render and modify the geometric shapes much faster. Vector data can be of a node, way, or area type. Each different shape is stored in separate files. The data has an attribute table, which is used to describe a property of an element. For example, name, street name. A Shapefile file structure consists of three mandatory file types, these are: .shp, .shx, .dbf. The files are stored as binary files. All three file types must have the same prefix. (E.G.: city. shp, city.shx, city.dbf)

The .shp files extension refers to the main content of a Shapefile. The geometric data for each vector is stored in the .shp file extension seperatly. At the beginning of the file, it contains a fixed-length header, which is a fixed length of 100 bytes of data. The main header is followed by rows of records of variable length. A record is made up of its own header and its contents. The contents of a record, describe the type of shape it contains data about. The data describing the content is followed by coordinates of the shape. The number of coordinates in a record is determined by the type of shape specified before.

In the .shx file extension, the indexes of the .shp files are stored. At the beginning of the file is a header, that is the same as the header of the corresponding .shp file. After the header, the records are stored line by line. The size of the records is a fixed 8-byte

length. The order of the records is the same as the order of the data in the associated .shp file. Each index record refers to a pair of records in the same .shp file. It is stored in a record for its length and how many pieces and points it consists of.

The dBASE file format, .dbf file extension, contains any number of required shape attributes or attribute keys from which other tables can be attached, The .dbf file is standard on many windows or DOS applications. There are three major requirements for a .dbf file to be valid. The name of the file must match the names of the associated .shp and .sx files. Only one shape property can be stored in a row for a given column. The properties must be in the same order as the geometric data in the .shp file. The dBASE header must be a value after the year 1900.

There are additional, optional Shapefile extensions too. With their help, a Shapefile can describe additional data and properties.

GEOJSON file structure[3]

The GeoJSON (RFC 7946 - The GeoJSON Format) is a file format for storing geographic data. A JSON file format designed to store geometric data. Many web APIs use the GeoJSON format. Such as the Leaflet library, which is used by several geographic information systems (GIS) software to display and read(such as QGIS). Using the structure of the JSON file format, it can store various geoinformatic vectors as JavaScript objects. A GeoJSON object can store the following types of shapes: „Point", „MultiPoint", „LineString", „MultiLine-String", "Polygon", "MultiPolygon" and „GeometryCollection". A GeoJSON file can store shapes(„Geometry"), spatially delimited entities („Feature") or a property list („FeatureCollection"). In a Feature GeoJSON file, it refers to a geometric element and its associated properties, the contents of a FeatureCollection are a list of a Feature (fig. 1) shows the file structure of a GeoJSON.

Fig. 1. A GeoJSON File format

An object must have a „type=" property that refers to one of the seven types. A GeoJSON object must know which of the seven types it refers to, to understand the interpretation of the data.

To represent a point, you need to specify the latitude and longitude values under the „coordinates" attribute. For a point, this refers to only two coordinates, while for lines and polygons, it refers to the totality of points.

Leaflet libary[4]

Leaflet is a free open source JavaScript Library. It can create an interactive mobile-friendly, web based map. Developed by Vladimir Agafonkin, Available at https://leafletjs.com/ URL.

Leaflet Draw[5]

Leaflet Draw is an extension for the Leaflet library, that is responsible for creating vectors on the map. It provides support, for creating and modifying shapes created on the map. It provides the ability to interact on the map, in real time (E.G.: Draw a shape on the map). It is responsible for drawing vectors on the map which the website uses. It allows for the users to map the areas which they deem safe or fearful, using polygons. The usage of Polylines are also available for mapping the average route the users take. Available at https://github.com/Leaflet/Leaflet.draw URL

Simplicity, performance and usability are the core design pattern in which the library

was created. For a research website, it is important that it is easy to acccess and that as many users as possible are able to complete it. Leaflet library is simple and transparent to operate on, so it was chosen to be used on the website.

2. The operation of the website

As a first step, when you a user opens the website, they are presented all the currently avaiable forms to choose from. The user chooses the most relevant form, to begin the usage of the website. The chosen form data is selected, from the database and displayed on the next page for their use. On a questionnaire there are two types or questions to choose from, drop-down and free answer input questions. When completing the questionnaire, the responders select the one that best suits them from the drop-down option answers. Free-answer questions shall be answered to the best of their knowledge. The answer will be saved in the database. Filling out the form, is possible with or with without a registration. If the user is registered, their user name will be entered to the submitted worksheet. In the case of a non registered user a computer generated ID, will be saved to their worksheet. The computer generated ID is unique for each and every responder that fills out the website. It is saved on the database and the users machine. Repeated usage of the website with their unique id helps to identify the user.

When filling in the shapes on the map, the user is able to indicate in red the areas they find fearful. The green indicator can be used to represent the areas, in which the responder finds safe to commute. The white marker is used to represent the daily route, they have traversed.

Upon registration users will be able to create their own account for the use of the website. To create an account, they must provide their own username, email address, and a password of their choice. The web page checks if the selected username is taken or available. If the database does not contain the chosen username, it will be registered.

A user can log into their account, using the username and password pair, which they given during the registration. In a case of an administrator user, trying to access the login module. It is checked whether the specified username has access or not, to the administrator menu. If the user has appropriate right to access the administrator menu, the access to modify or create new forms is given to the user.

A user with administrator right can retrieve saved data, from the database, under the administrator tab. They can query the data for any of the markers used on the map separately, or for all types of markers together. It is possible to download all or any answer to questionnaires, in the selected form or all available forms. As an additional option, the administrator can specify the time period within, the collected data can be accessed. Map data can be retrieved from the website in both .csv and .GeoJson fileformat, while questionnaire data can only be requested to download in .csv file format. There is an option to download the data of users who, filled out the form. The number of times they have filled out the form and which worksheet they filled out can be downloaded as well.

Users with administrator privileges can modify any form. It is possible to change the content of any questionnaire, either by adding a new question or removing, an unused one. There is a list of map and questionnaire help, to fill out a form.

An administrator can create a new form under the appropriate tab.

3. The use of the Website

For this section of the paper, the usage of the website is presented from two perspectives, a users and an administrators. While the main activity of a user, is filling out the form, users with administrator

privileges have, have higher privileges to configure the page and retrieve any submitted data.

At the time of writing, the website is available in four different languages, Hungarian, English, Portuguese and Spanish. The research in carried out in four cities: Székesfehérvár in Hungary, Manchester in the United Kingdoms, Porto in Portugal and Bilbao in Spain.

The appearance of the home page (fig. 2). Users can choose from the current and active forms to which they wish to submit a response. The questions of the current Székesfehérvár questionnaire and the help list for using the questionnaire and map can be seen from figure 3. Multiple types of questions are supported by the questionnaire. Two kind of questions exist, multiplce choice questions and simple text entry fields.

The map is on Figure 4.

Administrator View.

After logging in as a user with administrative privileges, more options are presented for them on the website. A registered user who has administrative priviliges, will be given access to the

Fig. 2. The home page of the website

Fig. 3. The questionnaire belonging to Székesfehérvár form

Fig. 4. The usage of the map

administrator menu, after entering the correct username and password combination. Due to the scalability of the web interface, an additional module has been developed, to create a new form. After logging in as administrator, the user has the option to manage, delete, deactivate, delete, activate or even create new forms. A form will not be shown, when it is in the inactive state. It is not possible to take in any type of response while deactivated. While in deactivated state, the form still stores any previously submitted response. Access to an inactive form is limited to the administrator user.

A new name for the location and the name of the location need to be entered when creating a new form. The name of the new form location must be one word and without any special character. The field for the new language of the new form, must be a two letter code which is the code of the given language according to the ISO 639-1 standard (E.G.: Hungary-HU, Spain-ES). After entering the required field, and pressing the confirm button, the new form is created. The user is taken back to the main page with the parameters belonging to the new form. All fields are created by default with default text. These fields can be modified at will. Upon creation, the form is in deactivated state, and can only be accessed

by the administrator.

The questionnaire, of any form can be modified by the administrator user, on the Modify Map page. The current map is displayed on the currently selected form, along with its latitude and longitude coordinates and the level of zoom. a Preview button is created for the purpose of testing out the coordinates. Entering correct values into the correct fields, and when the preview button is pressed, the map is updated real-time. The center of the map is represented by the longitude and latitude values. While using the preview button, no data is being saved. Saving data only happens after pressing the Save changes button. Upon pressing the Save Changes button, the input values of latitude, longitude and zoom level are saved, to the websites database. After saving the values, it is possible to safely leave the page.

Most data, which is used to help navigation on the page can be configured on the Main page Modify page. A help to users, when filling out the questionnaire or the map is provided with each corresponding step to take. While modifying the main page, it is possible to add new steps into any of the helping list or even modify an existing one. The deletion of a not used help list element is also possible.

A deactivated question can be reactivated at any later date. The deletion of any question is also possible for an administrator. Upon selecting any questions to be deleted, the website prompts the administrator for further confirmation.

Once a question is removed, all submitted response to that question is deleted as well. New questions can be submitted to the questioner.

There are two kinds of questions that can be created. Multiple choice questions and free input type questions. When multiple choice question is submitted the website presents a new page where the choices can be given for the question.

4. Conclusions

The representation of an online map website is explored through the use of the OpenStreetMap database. The basic elements to represent an object in OpenStreetMap is presented. The structure of a ShapeFile and GeoJSON file format are presented in their chapter. The library called Leaflet for the use of an online interactive mobile and desktop friendly environment is shown.

The usage of the website used to help the research to measure the fear of crime is presented through both a registered, an unregistered and an administrators point of view.

Notes:

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