USING OPEN SOURCE TO CREATE A GEOGRAPHICAL INFORMATION SYSTEM FOR BLOOD DONATIONS

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Keywords: Open source, Geographic information systems, Blood donors, Database management systems.

Abstract: The increasing development of Free/Libre Open Source Software (FLOSS) paradigm has brought a reduction in the cost of software development and increased its speed, resulting in quality improvement and constant evolution. Examples of applications that greatly enhance this area are geographic information systems (GIS). They permit the allocation of raw data or processed information in a map, allowing contextualization of the information itself and knowledge extrapolation. The transfusion medicine is an excellent area of health in which one can use a GIS to display the geographic distribution of blood donors on the map. A FLOSS GIS is feasible in this context thus reducing the high governmental costs in Health Care Area. The information can be easily displayed without copyrights and other complications. For these reasons, we decided to develop a platform that allows the display of information relative to the blood donations. Our goals focused on: researching the state of the art off current status; data manipulation and processing of the donor's database; and modelling and developing a program that could show a varied option of queries that can be done to the database. We used some statistic approach to the data as well as software implementation. After its completion, it was possible to calculate the distribution of blood donors and cross reference this with the places of collect. The distribution of the donors by group or area was made visible for interpretation purposes. Ultimately, the feasibility of such systems is proved and the changes in blood donation management can represent an important improvement towards good care.

1 INTRODUCTION

1.1 FLOSS in Health Care

The development paradigm using FLOSS has a significant role in several areas of the market, however, his use in health care is still limited (Karopka, 2009). Some of the reasons for this scenario in the health field are (Karopka, 2009; Rua, 2009; Baj, 2009): a lack of involvement of infield specialists (doctors, nurses, laboratory technicians, physiotherapists, etc.), a lack of appropriate training and knowledge of health professionals about the importance and benefits of these projects. Also, in health area, the requirements of security and reliability are extremely high. With FLOSS, not always these requirements have clear and defined rules that ensure health managers they can be fulfilled.

Despite having to face and overcome these challenges, FLOSS development has certain features that allow its viability within the health area. For example, a FLOSS that is designed and maintained by the Internet for virtual communities, in which continuous tests are made, leads to greater reliability and availability of updates. This allows the health authority to have access to technologies faster than in the case of proprietary software (Baj, 2009).

Another advantage is that FLOSS provides more opportunities for customization and enhancements. They were able to manipulate the code and customize it, for example, adapting it to a specific unit within the entity. These manipulations were not

de Souza Gaspar J., Leal J., Rolando Azevedo J., Hedayioglu F. and João Cruz-Correia R. (2010).
USING OPEN SOURCE TO CREATE A GEOGRAPHICAL INFORMATION SYSTEM FOR BLOOD DONATIONS.
In *Proceedings of the Third International Conference on Health Informatics*, pages 499-504
DOI: 10.5220/0002765904990504

possible through proprietary technologies (Baj, 2009).

Some of the motivations that drive government initiatives in this regard are (Fernandes, 2004): (a) reduction with initial software and updates; (b) increased control and access to intellectual property; (c) reduction of trust in organizations of proprietary software development; (d) use of software in the public sector as public property; (e) adaptability and modularity allowed by open source software to the needs of each government area or sector of the same institution.

1.2 Transfusion Medicine

Transfusion Medicine practice has as fundamental purpose the attainment, availability and accessibility of blood and its components. They must attain a desired level of quality, safety and effectiveness.

Still actually, worldwide blood donation is insufficient to the existing needs (Nilsson Sojka, 2007). The medical investigation and the technological breakthrough in this sector had a big boom thus allowing an improvement in this area. In other hand, the development of a health care structure, and the differentiation and sophistication of medical techniques led to an increase on blood demands. Simultaneously, people are ageing and as a consequence there is a reduction of people elective to be donors (from 18 to 65 years) and an increase of number of people who actually needs blood components as they grow older.

Other problem, specify from IPS (Instituto Português do Sangue), is the elevated costs inherent the definition of places for mobile blood collect places that present a low rate of donations. These costs vary from human resources (physicians, technicians, nurses, drivers, etc.) to equipment, among others.

1.3 Geographic Information Systems

Geography takes a fundamental role in almost all decision we made. The choice of places, the appointing of market segments, the planning of distribution networks, response to emergencies scenarios, the redrawing of countries frontiers, all those problems address geographic issues. Geographic characteristics such as topography and geographic dispersion of population are fundamental factors in fair resources distribution (Leitner, 2002).

GIS crosses regular data and their geographic position with the purpose of building maps. This technology allows us to visualize data with different degrees of complexity in a map. This gives us a useful way of reveling spatial and temporal relations between data.

Combining data and applying some analytical rules, it is possible to create a pattern in order to help answer the question previously made. The GIS primary goals in healthcare are (Maged, 2004) inform and educate health professionals and population, support decision making in many levels, prevent results before making any compromises, select priorities in lower resources environments, change bad practices and routines and continuously monitor and watch changes implementations.

Investigators, Public Health professionals, policy makers and others can use GIS to better understand geographic relation that affect health results, risks, disease transmission, health care access and other public health concerns. They're being used more and more often to deal with problems in a local, regional, national or international overlay (CDC, 2009).

Despite the evident benefits of GIS use, its dissemination and utilization it's not yet a generalized reality. Some possible explanation for this to happen can be (Rob, 2003): the lack of consideration towards user needs, elevated cost of existing applications and the need to learn the way they function and operate.

At requirement level, we verify an almost total need of community involvement since the very beginning. Meaning, users and developers must work directly together in the project. Only in this way can projects be realistic, reasonable and sustainable (Weiner, 2002).

The use of Geographic Information Systems in the field of Transfusion Medicine can use the data from donors, more precisely place of residence and blood type, presenting them in a situation so that there is an important tool for analysis and support for resource management more efficient and facilitates the accomplishment of its objectives are to operationalize the collection and distribution of donations. Contextualizing geographically frequency of donations, facilitates the planning of campaigning and the collection of blood donation to the needs of reserves replacement of components at the moment.

1.4 Motivation

The initial motivation to the realization of this project departed from the fact that the participants were involved in the health Care area, specifically in the collect and distribution processes and also being currently in the Master in Health Informatics study cycles of the Medicine faculty of Porto University.

One of the IPS necessities is to improve the planning and management of blood collect places utilizing donors' geographic analysis without increasing costs.

2 OBJECTIVES

2.1 General Objective

To create an open source Geographic Information System that would allow the graphic representation of the information concerning blood donations.

The Specific Objectives are (a) to facilitate the analysis, in a geographic context, of the blood campaign coordination process, (b) to support the professionals in planning and distributing resources for mobile collect posts, (c) to help the professionals define places and dates of mobile collect posts, according to the need to refill blood components stoking by blood type, (d) check that can develop open source software for health and their respective advantages and (e) to describe the systems creation process, exploring the motivation, difficulties and potentialities founded.

3 METHODS

This work can be classified as an applied and technological (Jung, 2009) research, because its goal is the development of an application allowing the graphic representation of blood donations.

Although this work has a statistical approach, it incorporates qualitative standards. The two methodologies are used to help carrying the whole process.

This work followed the following methodology:

- Research of Servers of the Maps for a GIS, functionalities and resources;
- Initial data analysis, treatment and statistical analysis of the data given by the Portuguese, Blood Institute;
- Building a prototype, design and create the database, design and implement the prototype;
- Evaluation meetings with the project team in order to improve the system;

3.1 Architecture

3.1.1 Requisites Analysis

Taking in account the overall characteristic of this proposal, the requisites where analyzed and defined by a multidisciplinary team composed of: a clinical analysis technician, a nurse and a computing engineer. For the application, the following requisites where defined are (a) to show the blood donation in the map, (b) allow that donation to be filtered by: Date, District, Council, Lab results, Collect places, Blood group, Rh factor, Gender, Age, (c) show the mobile collect posts and (d) develop the application using open source technology.

3.1.2 Languages and Development Tools

The development tool uses the programming language PHP 5.0 and MySQL database. The server maps to present the results defined by the software was the Google Maps version 2.0. However JavaScript and HTML functions will also be used;

In order to fulfill a good usability CSS and JavaScript JQuery v.1.3.2 framework styles will also be used. Another resource used is AJAX, which allows greater interaction with the User.

3.1.3 Diagrams

When open, the software executes a query to the database, to fill the respective fields of the filters, as showed in figure 1.

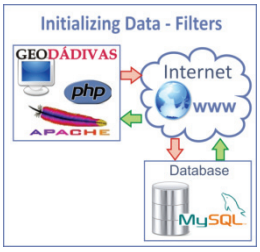

Figure 1: Diagram Initializing Data Filters.

Consultation of blood donations, according to the selected filter, is displayed in the software by following iterations showed in figure 2.

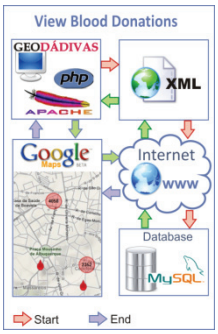

Figure 2: Diagram: View Blood Donations.

The main activities diagram was elaborated grouping activities by actors, as showed in figure 3.

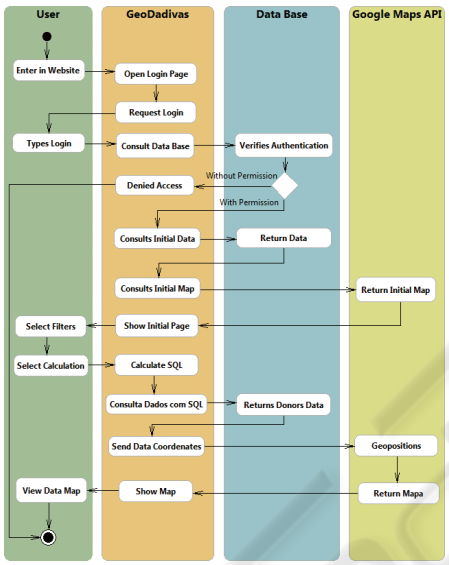

Figure 3: Activities diagram.

3.2 Implementation

In the diagram in figure 4, one can see the list of GeoDádivas system files and also the interaction between them.

The map server chosen for this software was Google Maps (map visualization free service utilizing satellite images). Besides maps and satellite images, it provides routes between pre-determinate spots, zoom, dragging the map, among others (Davis, 2006). The simplicity and open source methodology are its biggest assets. The grabbing and dragging possibility, increase or decrease zoom without big delays in the web page are a few of the simple tasks that favor it.

The functions *javascripts labeledmarker.js* and *markerclusterer.js* and the *Jquery library* are also used. All distributed by GNU licenses.

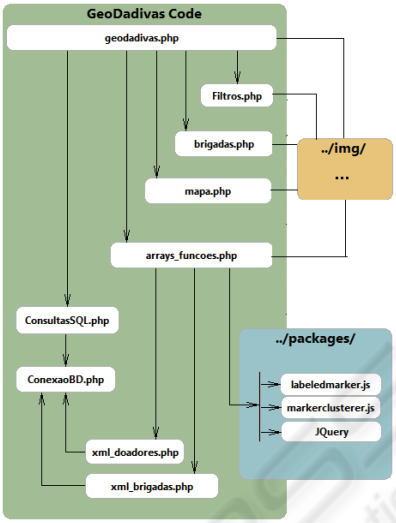

Figure 4: Diagram: Files Interaction.

3.3 Application Interface

The primary interface of the application has three distinct parts, a header in the top of the page and two columns, one of filters on the left and another of results on the right as we can see in figure 5.

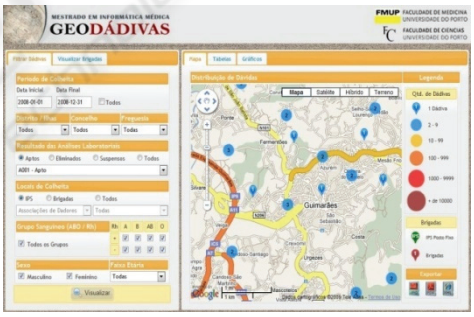

Figure 5: Main Application Window.

4 RESULTS

4.1 Data Analysis

The database used for the prototypes refers the blood donations occurred in the northern region of Portugal between the years 2000-2008. The initial analysis revealed that the database possessed approximately 634000 entries, and were used the respective variables: date, donor, gender, birth date, zip code, blood type, Rh factor, triage results, collect results and lab results. After statistical analysis, we can verify that the frequencies distribution is similar to the Portuguese study of blood types (Duran, 2007)

in which 46.6% of the population has type A, 3.4% AB, 7.7% B and 42.3% O.

4.2 Clusters

Analyzing the first results, it was noted that no conclusion can be drawn from first images showed. Because there were many blood donors, a marker on the map for each donor had a result as or more confusing to interpret than looking directly at a table data, figure 6.

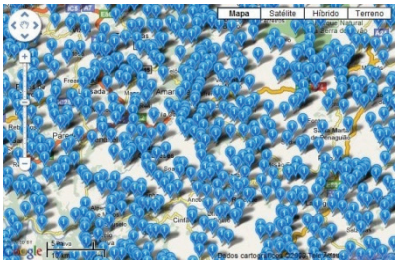

Figure 6: View Blood Donations without Cluster.

From these results, it was defined the need for developing clusters (aggregating relatively close donors together, geographically).

4.3 View Blood Donations

In figures 7 and 8 we can see the difference in existing donors with type A and AB on North Portugal region. Being AB a more difficult type to obtain, collect posts positioning can be easily managed.

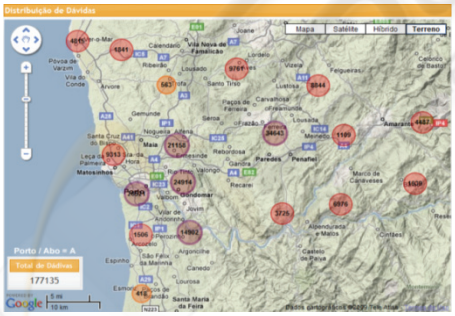

Figure 7: Blood group A donation.

4.4 Sapo Summerbits 2009

Software GeoDádivas was one of 10 winners of the "Projecto Sapo Summerbits 2009" (Software Livre, 2009). This project is inspired by the Google Summer of Code. In this initiative, scholarships are awarded to students of Portuguese universities to develop code to free software projects, existing or new, that use GNU Licence (Sapo, 2009).

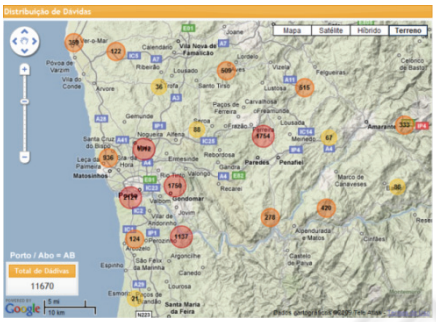

Figure 8: Blood group AB donation.

In figure 9, a most detailed visualization can be made after a zoom in action.

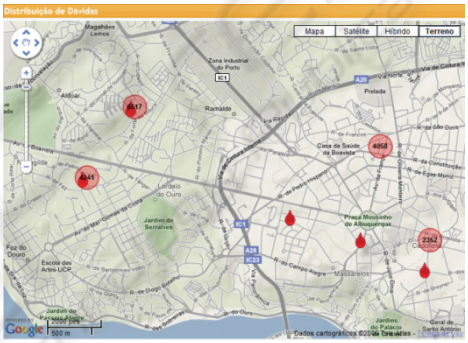

Figure 9: Detail of Blood collect places in Porto city and donors distribution.

4.5 Repositories

Repositories where GeoDádivas codes can be found, as well as their licenses are:
Software Livre: http://softwarelivre.sapo.pt/geodadivas
Source Force: http://sourceforge.net/projects/geodadivas

The software is currently hosted in the CINTESIS and can be used on an experimental basis as it uses a database of tests:
http://geodadivas.gim.med.up.pt

5 DISCUSSION

After the completion of this work we can realize that the GIS development is a complex system that needs much research.

The fact that it was developed by a multi-disciplinary team was essential towards its realization. The view of (a) the professional that is integrated in the entity where the system will be implemented (Clinical analysis technician),

combined with (b) the scientific analysis view from other health care area and (c) the technologic knowledge of the Informatics professional constituted an important point in its execution.

As the treatment and data manipulation revealed itself a difficult task, the software development became more complex.

We can conclude that all the initial project of data treatment (analysis, integrity verification, validation, and comparison with other scientific studies already done), although having consumed the majority of time spent, was crucial to final work quality.

The frequencies of the variables in our system are consistent with national published studies. This gives us an additional prove of data integrity quality.

Initial tests revealed that a GIS Open Source system is feasible in this context. Also we could realize that Google Maps API can support big volume of data in each query and Web 2.0 technology and JQuery UI Framework were a good choice in this experimental project phase, especially in relation with the user-system interaction.

The cluster method partially solves the graphic visualization problem, reducing the markers' quantity relatively close between themselves. However, after system conclusion, we could verify that clusters could easily create an optic illusion of blood donation, when less zoom was utilized.

For future work we suggest that other functions can be added and existing ones can be improved, namely:

- possible use of colorized polygons that delimitate cities can be used in replacement of the cluster solution because they can facilitate the visual interpretation;
- more complex functions to establish relations between different variables such as calculation the distance between donor's houses and blood collection places;
- determine with higher precision the location of blood collect places with lowest frequencies that represent high resources consumption;
- relate the population density with blood donations in certain areas.

ACKNOWLEDGEMENTS

To Dr. Jorge Condeço, Head Chief of the Informatics/Hemovigilance department of the CRSP-IPS, IP (PBI, 2009), for all the help and collaboration in obtaining the data and its treatment, analysis and comprehension.

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