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Development Of Open-Source Applications Using WebGIS Technology

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Keywords	Abstract
Internet based GIS GIS Open-source Application development GeoServer	In this day and age of technology advancing at a rapid pace, it is very important for people to understand the world they live in and know where in the world they are. With the support of rapidly developing technology, it is much easier for humans to access spatial information than it used to be. Geographic information systems (GIS) can now be used with inexpensive mobile devices. These devices can be GPS, handheld computers, tablets, or even cell phones. With the spread of the Internet, the importance of geospatial information systems became much better understood. Today, such powerful geographic information systems can be used via the Internet (Yandex Maps, Bing Maps, Google Maps, OpenStreet, etc.). In the present day when Web-based GIS applications rapidly spread, and commercial or free source-coded GIS infrastructures can be found easily, a GIS application that has the basic GIS functions that hold the information of historic places and buildings' information by using a GeoServer can be realized. This study including the documentation of this application will supply basic and general information about how a GIS system is and how it works to those concerned about it. The web application that is a part of the study has been developed by Phyton, GeoServer, and PostgreSQL Server and has been designed and realized to be able to keep a historic place's geographic and written information. The application can be seen in two parts; the first part is the part that keeps the written data. Written data is kept through PostgreSQL Server. And the second part is the part that keeps the geographic data. Geographic data is kept through map source files and published through GeoServer. Those maps that are published through Python can be viewed through the web pages. Several basic GIS operations can be done via a web page. Besides the detailed information on GIS, wide information about the technologies necessary for developing the GIS applications via the internet and internet technologies are included within the documentation of the study.

1. Introduction

Location is the key to understanding the world in which humanity lives. Knowing and using the location increases the rhythm of life. Thus, people want to know their surroundings and where they are. Electronic device manufacturers and software technology companies (such as mobile phones, PDAs, handheld GPS, Google Maps, Google Earth, and Microsoft Virtual Earth) use technology and science to meet people's demands. These technologies become habitual for the people who use them. They do not go to unfamiliar places without looking on the internet, or they send their location or meeting point to their friends using the GPS features of their phones. Today, GIS technologies or related technologies are entering our lives at an increasing rate, and we welcome these technologies sincerely.

The aim of this study is to show how to develop web GIS software and use it with an ordinary internet browser. In the next chapters, the problems, and difficulties that I encountered during the work will be presented. Anyone who develops GIS software within the framework I have made can use these solutions.

2. Method

2.1. GIS Applications using the Internet

The Internet is an endless interactive medium and source of information. Someone needs to produce this information and present it on the internet so that others can access it and use it for their own purposes. Several online GIS software has appeared in recent years (Google Maps, Yandex Maps, Bing Maps, OpenStreet, etc.). These online apps are indeed quite useful in our daily life. These powerful GIS applications convert GIS data into basic images and HTML code and serve in this form so that an ordinary internet browser can easily interpret the code and display output maps and graphs. Internet technology has reinvented itself and taken to an incredibly different level, but underneath all that, programming languages are no different than they were 5 or 6 years ago. We used HTML and Javascript back then, and we still use HTML and Javascript today. Although we use the same programming languages, our usage patterns have changed a lot over the years. In this section, internet technologies and internet programming languages will be explained as broadly as possible.

2.2. Network Technologies

The basic components of the Internet are "packet networks" (called "nets" for short in the rest of this section). This term refers to any technology capable of transferring data packets from one computer to another; Figure 3.1 shows an abstract view of such a network. Usually, many computers are connected to the network, providing them with "addresses" that can be used to specify the source and destination of packets. Most computers connected to networks are classified as "hosts". These are computers rather than running programs; desktop computers and servers fall into this category. Few computers provide functions related to network operation only. For example, "gateways", "routers" and "bridges" transfer packets between networks. There is a wide variety of technologies that fit into this general pattern. For example, LANs such as Ethernet (Şahin & Yakar, 2021) use medium access control (MAC) addresses. These are 48-bit addresses allocated by manufacturers of interface cards installed in hosts. The "network service" provided by a LAN is simple: a computer creates a packet containing the destination MAC address and asks the network to deliver it, just like sending a letter. This is called a "connectionless" (CL) service. For example, a quite different style of service is provided by asynchronous transfer mode (ATM) (Yakar et al., 2014) networks. In these networks, there is an initial negotiation phase where the computer tells the network what type of data it wants to send and the address of the destination. This gives the computer the opportunity to determine the quality of service (QoS) it needs (throughput limits, transfer latency, etc.). The network must decide whether it can meet the demand. If it can, it tells the computer that a "connection" has been established with the target, and data transfer can begin. This is like making a phone call, where the person dials a number and makes a call before the conversation begins and is called a "connection-oriented" (CO) service. Addresses in CO networks are used only during the connection establishment phase (Farrel, 2004).

Almost all network technologies provide services similar to those just described, although the mechanisms they use to implement the service are radically different. However, there are many strange differences within these broad categories: each technology imposes its own limit on the size of a packet that can be sent, each has its own unique addressing scheme, some technologies allow fine control of QoS, others do not, and so on. . These differences create difficulties for network interconnection. We cannot receive packets from one network and forward them to another; any kind of subtle transformation will be required. The solution is "convergence". We invent an abstract network service and provide "convergence functions" to implement the abstract service for each network technology. In this way, we make all networks look the same and the interconnection problem becomes manageable (Anderberg, 2002).

3. Results

The aim of this study is to develop a web-based geographic information application to publish historical property data using Python, GeoServer, PostGRE SQL Server, and PostGIS. The web application consists of two independent parts, the first is the internet map application and the second is the common database application. Map application was developed on GeoServer. The second part is developed in Python, this application uses PostGRE SQL Server as its database. The map application stores the geographic features of the point or area, and the database application stores text data about a point or terrain feature. With these two data types, all properties of the property can be stored and presented to users. Basic calculations or analyzes such as distance and area measurement can be made with Javascript. The phases of the project can be written as application design, coding, and development.

3.1. GeoServer

GeoServer is an open-source software server written in Java that allows users to share and edit geographic data. Designed for interoperability, it publishes data from any large spatial data source using open standards. As a community-driven project, GeoServer has been developed, tested, and supported by various individuals and organizations from around the world (Alptekin & Yakar, 2021). GeoServer is the reference implementation of the Open Geospatial Consortium (OGC) Web Feature Service (WFS) and Web Coverage Service (WCS) standards as well as the compliant Web Map Service (WMS) with high-performance certification. GeoServer forms a core component of the Geospatial Web.

3.2. Postgres SQL Server

PostgreSQL is an object-relational database management system (ORDBMS) based on POSTGRES, Version 4.2, developed at the University of California, Berkeley Department of Computer Science (Erener & Yakar, 2015). POSTGRES pioneered many concepts that only became available in some commercial database systems much later. PostgreSQL is an open-source descendant of this original Berkeley code.

3.3. PostGIS

PostGIS is a spatial extension of the PostgreSQL relational database created by Refractions Research Inc as a geodatabase technology research project. Refractions is a GIS and database consulting firm headquartered in Victoria, British Columbia, Canada, specializing in data integration and custom software development. PostGIS is now a project of the OSGeo Foundation and is developed and funded by many FOSS4G developers and organizations around the world who benefit greatly from its functionality and versatility (Tona et al., 2022). The PostGIS project development group plans to support and develop PostGIS to better support a range of key GIS functionality in the data source areas for OGC and SQL/MM spatial standards, advanced topological structures (scopes, surfaces, meshes), and desktop UI tools.

3.4. Application Design

Enterprise applications deal with huge amounts of data. With this type and amount of data, performance is the first problem that comes to mind. When performance has to be considered, the architecture of the application becomes more important. The design of the database and the design of the application must be compatible with each other. Both main parts of the application should be designed with the other in mind. When developing such an application, the application must be divided into smaller parts, these parts are called layers. Enterprise applications mostly consist of three layers; The database layer where database operations are performed, the business layer where calculations and data transformations are made, and the interface layer where the user interacts with the system. As seen in Figure 1, the layers are placed in order and data operations should occur in this order. The first user places a command from the website, which is the top layer. The business layer processes the inputs and converts the input to the required object type and calls the function in the data layer and passes the inputs to the data layer function. The data layer function connects the database and sends query sentences to the database engine and the database engine runs the statements on the database and if there are return values passed to the business layer.
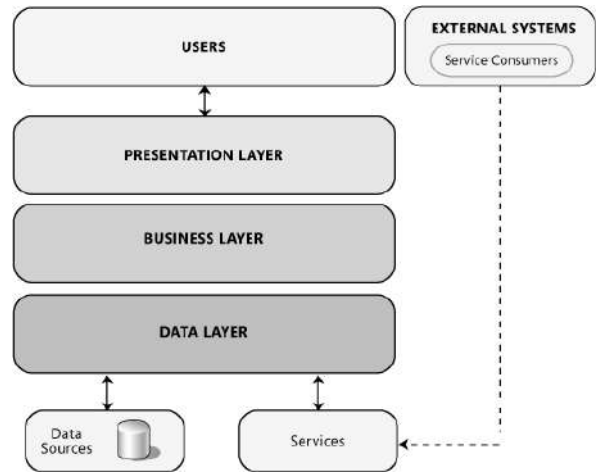

Figure 1. The main layers of the application.
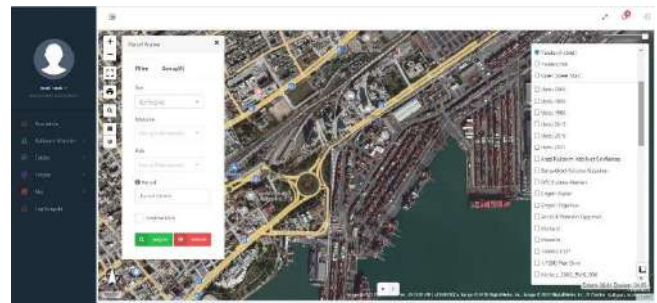
The homepage image of the application is shown in Figure 2.

Figure 2. The main page image of the application.

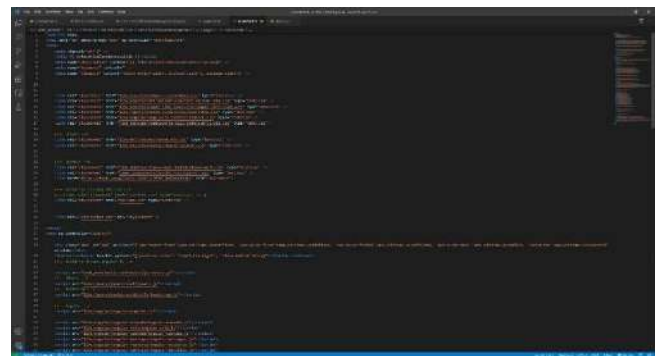The Frontend codes of the application homepage are shown in Figures 3 and 4.

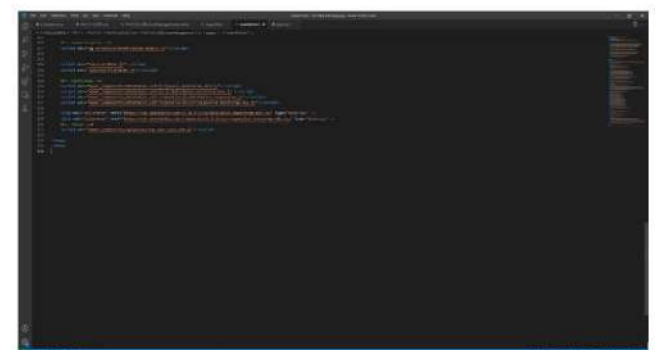**Figure 3.** Frontend codes of the application home page.

Figure 4. Frontend codes of the application home page.

DLL List Written for Application: In order for the application to work healthily and quickly, the libraries I wrote were created as DLLs. DLL (Dynamic Link Library) are libraries that contain functions and that these functions can be run, which are specially written in the project to which they are added. The list of DLLs I wrote specifically for the application is given in Figure 5.
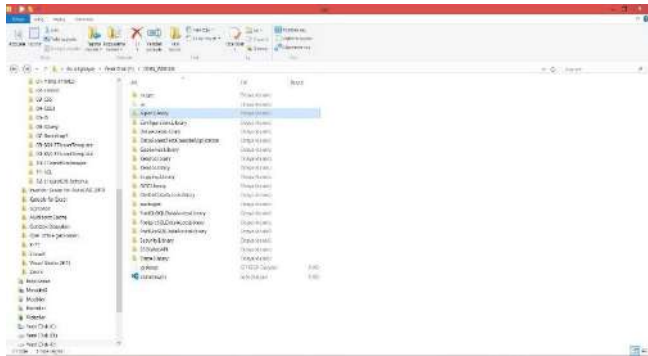

Figure 5. DLL list.

4. Conclusion

The main purpose of the study is to create a web-based geographic information systems application and by realizing this purpose, to create a website that publishes parcels, plans, various maps, and structures within the provincial border of Mersin. This website contains text-based information as well as geographic information. Geographical information is stored in the PostGIS server, published maps are stored in the GeoServer server, and non-graphical information is stored in Postgres SQL. The website is built on Python, Javascript, and HTML 5.0. Python is one of the best solutions for rapid application development. Ready-to-use components, easy debugging, and debugging are the outstanding features of Python. A mapping website was created using all these contemporary technologies, the site is quite large and comprehensive, but has the capabilities of most known GIS web applications. It also has a scalable infrastructure.

Every software project has its problems and challenges, that's the nature of software development. The success of a software project lies in balancing the cost and quality of the software. There were several problems encountered during the development phase of the project. The first problem encountered while configuring the GeoServer is that the GeoServer server is difficult to configure, and some points are easily overlooked. Another difficulty is the processing of spatial and text-based data hosted in the PostGIS server on the map that is associated and presented. Unfortunately, the documentation of these processes is quite inadequate. Another serious issue is performance. Performance and fast loading are very important considerations for websites as it is well known that the average internet user only takes sixteen seconds to load a web page in the browser. A web page must load instantly and must be accurate. The database and ArcGIS server must be installed and run-on different computers. Another performance-related issue has to do with client-side components and javascript. When working with image data the browser has to deal with large image files, XML, and javascript. These large files cause the browser to run slowly and sometimes freeze. Optimization is crucial for this type of application. Application codes should be optimized for the purpose. The sensitivity should also be at optimum, higher sensitivity introduces extra data overhead.

If we bring all the suggestions together, a GIS application should be installed on a three-node cluster system, Active-Active-Passive, and it is absolutely necessary for this cluster system to have redundant internet and power lines. All these data should be backed up by taking full backup instantaneously at the end of the incremental day in backup units, one on-site and the other off-site, hosted in different locations. The level of GIS data detail must be precisely determined. Extra high detailed data will reduce the performance of the application, but low detailed data that cannot meet the needs of people will not work.

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