IMPLEMENTING A REAL ESTATE MANAGEMENT SYSTEM USING OPEN SOURCE GIS SOFTWARE

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Abstract

Developing real estate in Kenya today has become a profitable business that is growing day by day. Many Kenyans living in towns and cities buy, build or rent a house. The aim of this project is to create a GIS system that can be used as a tool for those people who want to buy, sell or let their home in a fast, cheap and convenient way. By just looking at the GIS based site on the Internet, the interested buyer already gets most of the information without having to leave home or work. A topographic map of the area is acquired and then georeferenced to provide the background on which the parcels of land (plots) are displayed. Major roads and other important features and institutions in the area are captured and displayed alongside the plots and houses. The system is then put on the internet using Mapguide open source and then tested using Mozilla Firefox web browser.The research creates an online GIS system that allows users to search for land parcels (plots) for sale and houses to rent in Kasarani area. Users can run searches that suit their needs, e.g. search for a plot costing 500,000 Kenya shillings or a house costing 10,000 Kenya shillings per month in the area.All the land parcels satisfying this search criterion will be displayed for the user to select one that satisfies their needs. Conditional searches providing a range of results can also be performed e.g. one bedroom houses costing less than KSH10, 000 in the area. All houses satisfying the criteria will be displayed for the user to select one that satisfies their needs and then zoom into the area surrounding that house. This allows for closer analysis of the desired features. Spatial queries such as buffering, distance and area measuring can also be performed by the user.The system produced can be used by the realtor and the developers to help display choices available and easily make decisions using the map before making the physical visits on the ground. The use of open source software makes the system available to Kenyans realtors who may not afford expensive proprietary software based systems.

Key words:

1.0   Introduction

Urban growth is recognized as physical and functional changes due to the transition of rural landscape to urban forms. It occurs when the population distribution changes from being village to town and city (Rajesh and Yuji, 2009). Many regions of the developing countries are experiencing rapid urban growth. The urban growth rate in Nairobi is the highest in Kenya. As the world population increases every second, our urban areas are increasingly being faced with the problems of inadequacies of basic facilities such as good housing as a result of over population, rural-urban migration, etc. Hence, there is an increase in demand for the construction/setting up of new houses.

The majority of the people in Kenya that want to sell a property or house rely entirely on a real estate companies, individual brokers, newspapers or, more recently but to a lesser degree, the Internet. Unfortunately these sources do not provide an effective way to transmit all the necessary information that a customer needs in order to make an informed decision. For instance the newspaper provides the price, the size, the number of rooms and the exact location's name. However information such as, whether it is close to my work place, if there is any principal road access nearby will not be available on the newspaper advertisement.

The World Wide Web with the help of GIS facilities and the proper information background can give a customer exactly what they need in a fast and convenient way. Moreover the integration of GIS and the web allows easy access to useful GIS information and data without necessarily using any specific GIS software (Tyler, 2005). An Internet GIS server usually combines a standard Web (HTTP) server and a GIS application server, and the GIS databases and functionality reside completely on the server(s) (Daniel and Jinglan, 2009). Using GIS and the Web, it is possible to put the developer on the exact location of any property on sale anywhere on the region and get a pretty good idea of what this place is like. The surrounding area can also be easily examined for desired features. This information can then be used to identify those properties that are most likely to meet customers' needs (Ayalew, 2007). The focus of the system is to provide the potential buyers with enough information that makes them feel as if they have already been to the property. This allows property preselecting on the computer screen. The system will therefore save time for the seller and buyer.

Currently on the Internet there are many websites that offer some information on selling or renting homes in the country. They include: photos of the property, general location, price guide, size and general description. While this is useful information, for potential buyers it doesn't allow them to see it in a graphical way.

From the foregoing it is therefore a good idea to use the WEBGIS (Web based geographical information systems) as a tool to show the exact position of the plot and by querying any feature that involves the surrounding area to inform a client.

For instance, determine in a graphical way how many supermarkets, stores, churches, police stations are in surrounding area, simply by querying all of these features and setting the program to identify them within a specific radius of say 500m or more depending on the preferences of the client. The net effect is a more educated and more informed buyer, who is able to inspect many more attributes that can't normally be seen in the newspaper or ordinary Internet sites. In this method the buyer is not only persuaded by the houses appearance but also by its residential commodities and convenient location.

1.1   Real estate management systems
1.1.1   GIS for Real Estate

To a large extent location/geography drives the real estate industry (Atteberry and Rutherford, 2003). Effective real estate management involves not just finding any site but finding the best site possible (Tanakorn, 2007). Customers are not just interested in getting a site; they have preferences that the site must satisfy. To satisfy their customer's needs real estate companies rely heavily on GIS technology to deliver the results they need. By analyzing data around locations such as accessibility to major roads, electricity, clean water etc. GIS helps to find properties that match specifications for each client. GIS helps the real estate industry to analyze, report, map, and model the merits of one seemingly good site or location over another (Tanakorn, 2007). From identifying the best fit for new commercial development or matching a homebuyer's decision criteria to managing a property portfolio, a well designed GIS system delivers the required answers needed to make the best choice in real estate business.

"Users can walk through" the whole area viewing the different types of plots before settling on their preferred one. They can choose the type of environment to live in or to put up rental houses. (Chengda, 2001)

1.1.2   Application of GIS in Real Estate in other Countries

Real estate professionals are increasingly using maps in their property Web sites to create a more user-friendly and more fulfilling experience for consumers looking for homes. Examples of such sites include the Google Maps Miami Real Estate (http://www.miamibeach411.com). It provides users with the option of browsing a street map, a satellite image or a hybrid of the two. It assists to connect real estate developers, and buyers searching for investments anywhere in Miami, in a valuable way. The system provides an easy to use navigation tool that allows the user to just drag the map with their mouse, and use the slider to zoom in and out. Another example is the New York real estate (www.citycribs.com); this site integrates Google maps with its real estate database to provide its users with a rich and enjoyable search experience. It applies "mash-ups" to allow the home seeker to search for New York City apartments and homes on a map (complete with property information), then link to receive full details for each listing. Users are able to filter their CribsMap™ results by selecting a borough, property type, price

and desired number of bedrooms. Once a request is entered, each apartment or house location is then overlaid onto a Google map. Each listing is displayed as a pushpin, and by clicking on the pushpin, a small window pops up with the property details, price and a thumbnail image.

The systems described above make use of expensive proprietary GIS software. This pushes them way out of reach for many realtors in developing nations. Thus there is need to explore the option of basing such technology on open source GIS software whenever possible. As explained in the next section there exist many free and open source GIS software today which can readily be used for such endeavors.

1.1.3   Open Source Geospatial Software

Open Source Software (OSS) refers to programs with licenses that give users the freedom to run the program for any purpose, to modify it and even to freely redistribute it. Open Source Software can be defined as separate from open standards and open Application Programming Interface (API) technologies. Web-based mapping tools such as the services offered by Google, Yahoo and Microsoft have open APIs that can be accessed by anyone on the Web, but they use only some open standards, and end-users have no access to the source code.

By its nature, OSS has open APIs and it must follow open standards. The defining characteristics that differentiate OSS from proprietary tools are that anyone with a computer and an Internet account can download the source code of an OSS application and use it with no further licenses. With the advance of the Internet technology, open source software is becoming increasingly popular. As Mohammad Firuz (2004) asserts, there are several open source GIS software in the Internet such as Mapguide open source Quantum GIS etc.

OSS is crucial for the developing world. They enable poorer countries to develop their own technology instead of having to import it (Rafael, 2005). It is therefore necessary for developing nations and their donor partners to review policies for procurement of computer software, with a view to ensuring that options for using low-cost and/or open-source software products are properly considered and their costs and benefits carefully evaluated.
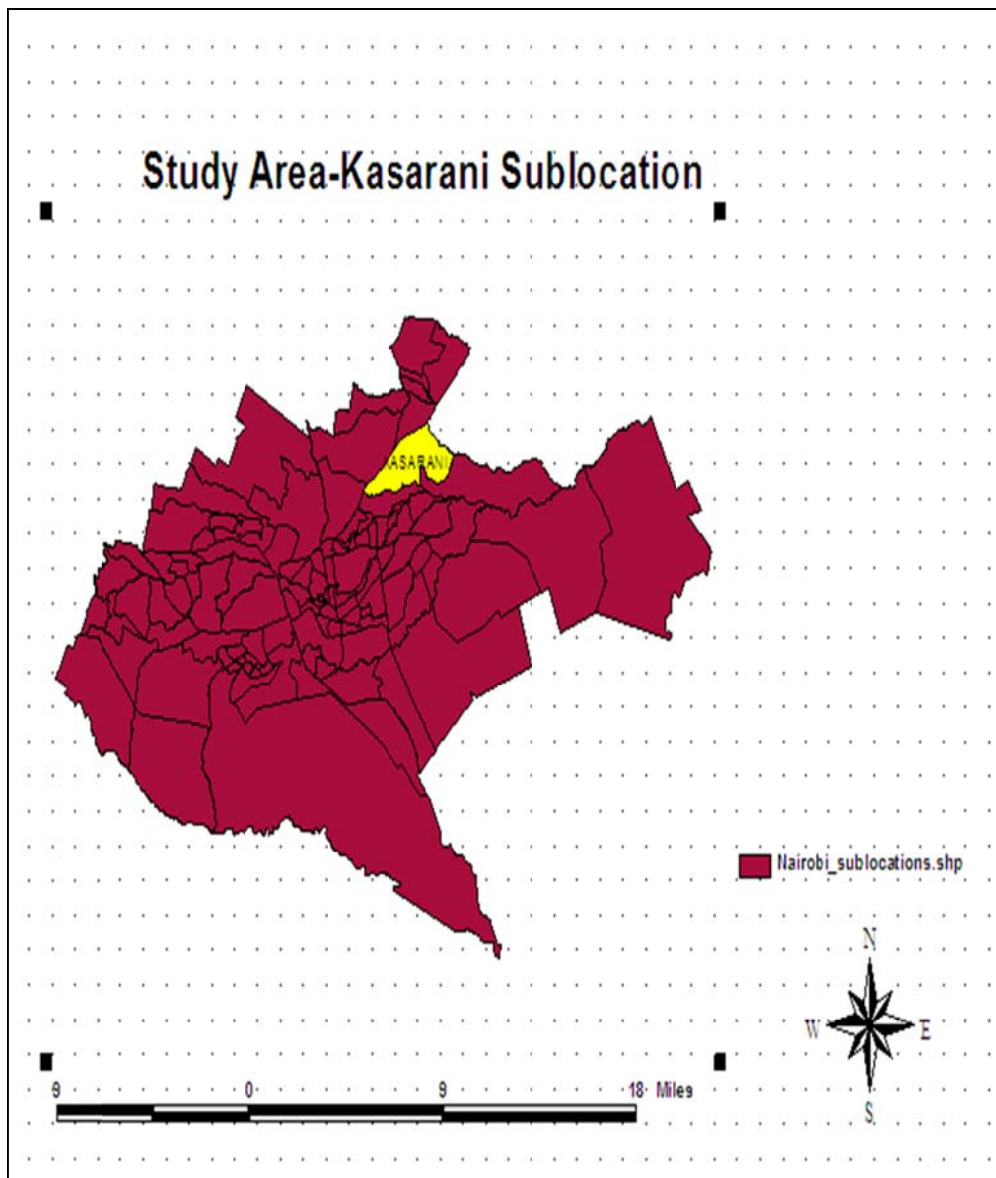
1.1.4   Study Area

Figure 1: location of Kasarani area within Nairobi province in Kenya

The study area (Kasarani Estate) Figure 1 represents the face of the fast growing Nairobi suburbs. About 10 years ago much of it was plain grassland. Today it has been converted to a densely populated estate with both commercial and residential houses coming up all the time. Being on the outskirts it still has great potential for expansion especially towards the eastern side. It is located 10 km from Nairobi City centre.

2.0   Methodology and Data
2.1   Data

This research aims at building up a GIS based webpage which can help people in Kasarani to "advertise", in the case of a seller or, "find" in the case of a buyer plots and houses through the help of Internet in a professional, convenient, and less costly way. GIS techniques are used to allow for preselecting of desire property before actual visitation on the ground. The user should be able to perform some GIS queries about a property of interest eg measure distance from a feature of interest such as a road, a dumping site, etc. The data used is given in Table1.

Table1: Data used in the research

Data	characteristics	source
Nairobi area topographic map	Scale 1: 5000	Survey of Kenya
Nairobi administrative boundaries (sub locations)	Scale 1:251239	ILRI
Land parcels	Scale 1:2500	Survey of Kenya

2.2   Methodology

The methodology adopted in this research is as follows:

Step1: Coordinate Transformation (Georeferencing) to WGS 84 UTM 37 South

The Nairobi topographic map was georeferenced prior to digitization. Kasarani sub location boundary map acquired from ILRI website in UTM was overlaid on the map to demarcate the study area.

Land parcels (plots) were acquired from (Survey of Kenya) SOK. The parcels were in Cassini soldier projection. Thus they needed to be projected in (Universal Transverse Mercator) UTM. The transformation was done using Microsoft Excel.

Step2: Data capture

Quantum GIS is used to digitize the parcels and other features on the map like roads, police station, police post, power supply lines, swamps and other important land marks in the area.

MYSQL DBMS was used to develop attribute tables for the data needed in this project such as type of house available for rent, cost, owner contacts etc

Step 3: Selecting Tools for Website Creation

Some quick trials (explorations) emphasizing mainly on ease of use ended in favour of Mapguide open source. This is a web-based platform that allows users to quickly develop and deploy web mapping applications and geospatial web services. It provides a powerful viewer that includes support:

- For feature selection,
- Property inspection,
- Map tips
- Buffering,
- Select within, and
- Measuring.

Thus Mapguide open source was selected for the task of putting the maps on the web. Mapguide open source was downloaded from the internet and then installed using the bundled configuration option which installs and configures the Apache HTTP Server, and PHP. Then a port for the Apache HTTP Server was selected. By default, the port is 8008, so that it won't conflict with any existing web servers that listen on port 80. The service name for Apache is ApacheMapGuide. The development environment is then selected as PHP.

Step 4: Selecting The Authoring Tool

Mapguide Maestro is the authoring tool for Mapguide open source. Its equivalent to Mapguide studio in the commercial version of Mapguide (Autodesk Mapguide). Map guide Maestro allows us to upload data, make layers, define the layers (symbology, labels, scale dependencies, etc.), and create maps.

Step 5: Creating a Folder Structure

In this step, the recommended folder structure for a new project is created. Folders for data, layers, maps, and layout were created for the project.

Step 6 Loading Shapefiles

The next step was loading SHP files. This is done by first connecting the data provider corresponding to the data to be loaded directly into a folder in the shape file folder.

Step 7: Making Layers

After connecting and loading the shape files the layers for the shape files were made.

Step 8: Connect to an MYSQL Database

In this section, a connection to the MYSQL database for the Kasarani plots and houses data was established and saved as a resource.

Step 9: Setting The Style for Layer

The basic style for a polygon, lines and point feature layers were edited by selecting a fill color and a border color for each layer in the project.

Step 10: Create a New Map
This involves creating new map and setting its properties. The basic description, of the map was entered here leaving the Coordinate System section blank (the map used the coordinate system of the first layer that was added to it). For Background Color, a light colour was selected (white).
The various Layers were then added to the map.

Step 11: Organize the layers in a map
Layers were organized in appropriate order starting with point features then lines and finally polygons so that viewers can see all the features clearly.
Layers that have not yet been edited were edited so that the layers in the map are displayed in color and at the appropriate scales. Labels were also generated on the map.

Step 12: Adding Tooltips
To improve on the usability of the system tooltips were included on the map
Tooltips are pop-up boxes that contain information about the features in the map. users will be able to view the tooltips in the Web browser. When a user points the mouse to a given feature a tool tip appears describing, briefly, the specific feature under scrutiny. Whenever a user places the mouse cursor on a feature the information set on the tool tips appears automatically.

Step 13:   **Setting up The Map Legend**
Some layers were initially turned on while others are turned off. Labels for the various layers are also set here.

3.0   Results and Discussions
3.1   Viewing the Map

A new layout was created and the map was embedded on it finally, the map was previewed in a Web browser as shown by Figure 2.
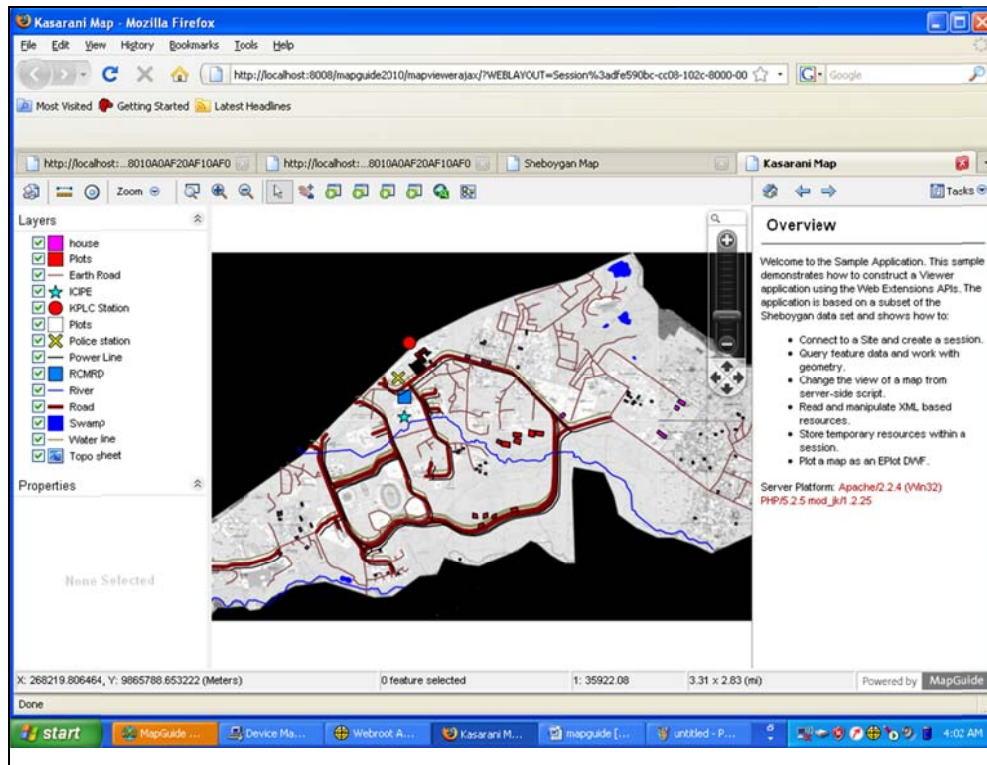
Figure 2: Final map on Mozilla Firefox

The content of toolbar, context menu and task menu was edited to include functions meant for this system as shown in Figure 3

Tool for searching plots and houses based on size and cost was added to the layout. Customers can search for a desired property simply by inputting the property or condition in the search tool. Figure 3 shows a customer searching for a plot costing 500,000 Kenyan shillings.

The results of the search are displayed on the right pane. All plots on sale that cost 500,000 Kenyan shillings are displayed on the map. The user then can select the one that satisfy their needs by inspecting their various positions on the map
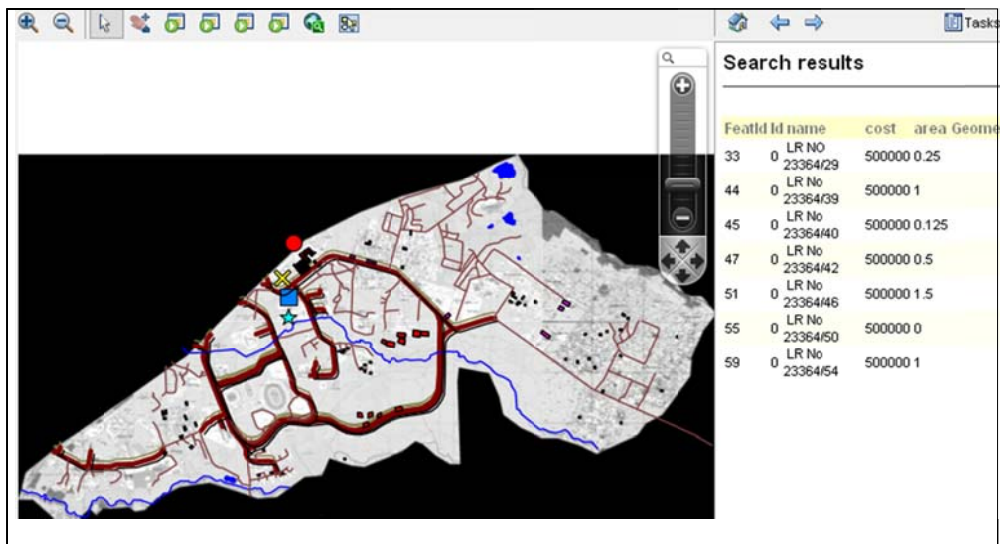
Figure 3: Search results on the site showing all plots costing 500,000 Kenyan shillings

A conditional search can also be performed so that one can get a range of results. For example one may be interested in houses that are costing less than a given amount eg 10,000 Kenyan shillings. Figure 4 demonstrates such a search, where the customer is interested in houses costing more than 10,000
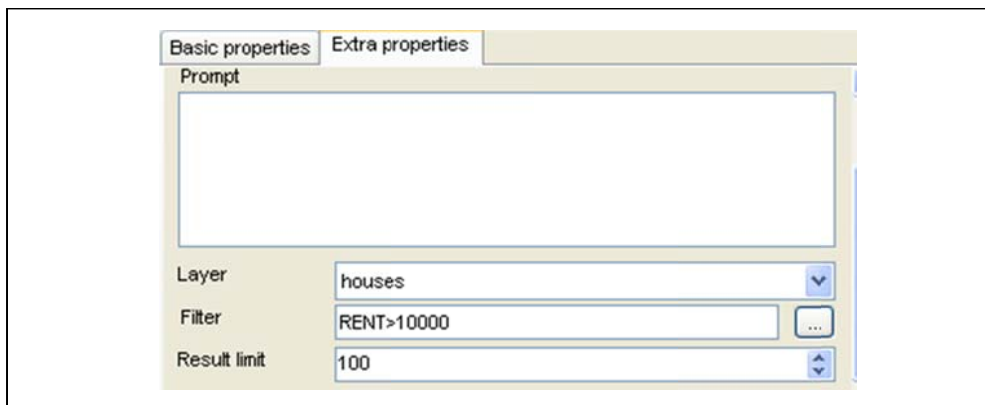

Figure 4: Searching for a house of rent more than 10,000 Kenyan Shillings
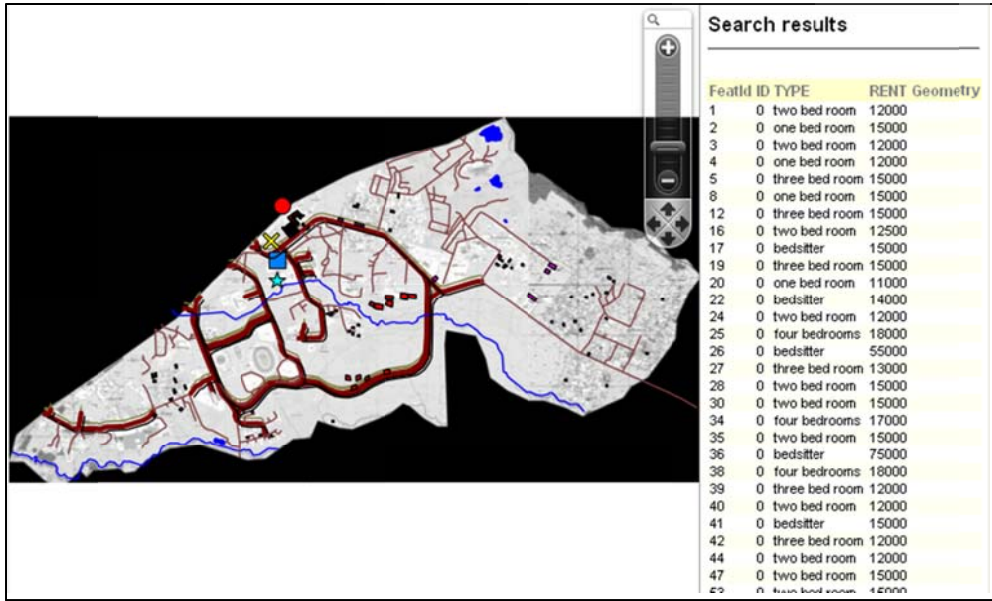
The results of the search are shown on Figure 5

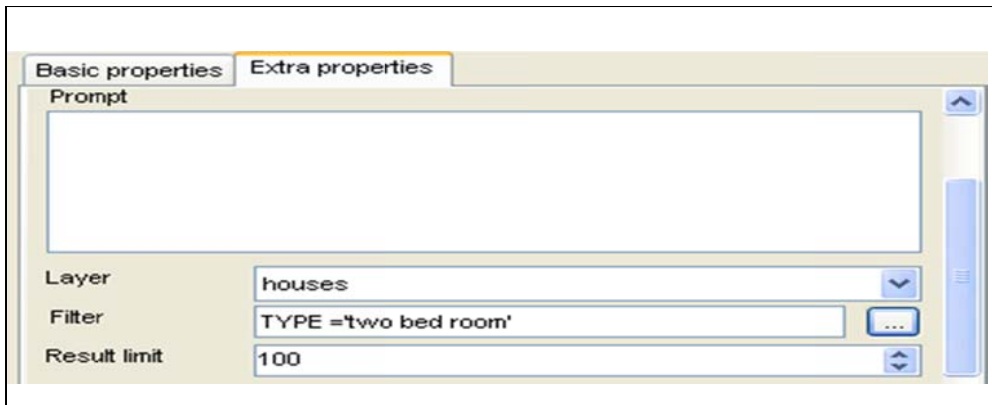*Figure 5: Results of conditional search*

Figure 6: Searching all two bedroom houses in the area that are available for rent

To create a search one needs to define the layer and the filter condition as shown in Figure 6.
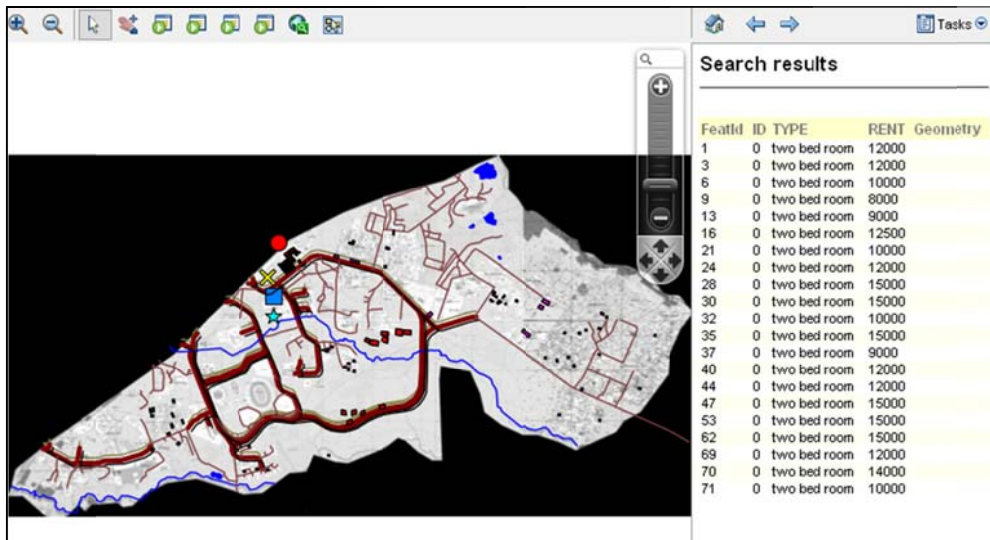
Figure 7: Results of the search for all two bed roomed houses and their cost on the website

When the search is run, all the results are displayed on the browser as shown on Figure 6. To move to the area and zoom on a parcel or house, one only needs to click on the selected house. The focus moves to that area allowing for a close examination on the feature in question, as figure 7 shows below.
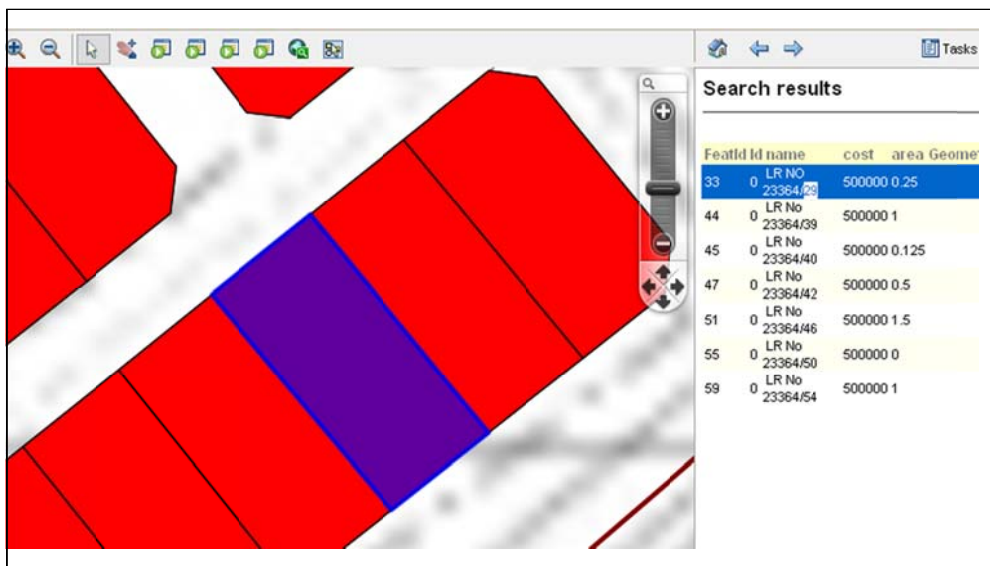

Figure 8: clicking a selected feature to zoom to it

The particular parcel is shown in different color. In Figure 8 above, the one in colour blue. The site also allows for carrying out spatial queries in the area such as buffering or measuring as described below.

3.2   Buffering

A user may be interested in ensuring that the area they rent or built their house is far or near certain features. For instance people will not want to live near garbage dumps or noisy night clubs. On the other hand some people may want to be near features such as roads or schools for the convenience of their school going children. It's easy to buffer on the site, just set the distance from the feature of interest. The results of the buffer just show the feature of interest and the desired features in the surrounding area. This assists in decision making without necessarily going to the field to observe the features.

3.3   Measuring

Customers may be interested in determining how far features of interest are from their homes. One feature of interest is more often than not the main road and the shopping center. The measuring tool can assist in determining the distance from any feature of interest.

4.0   Discussion

The open source GIS software selected for this project proved adequate for the desired tasks. One objective of the project was to show that open source GIS software can be used to produce a system to support real estate agents. This has been shown to be true, through the use of Quantum GIS to perform the GIS work; this is a powerful desktop GIS software providing most typical GIS functionalities. To cater for any unavailable functionality Quantum GIS provides a powerful user interface for GRASS tools (Gary, 2007). Mapguide open source as the map server, apache as the web server and MYSQL as the database management system, Firefox is used as the browser. All these are open source software available free for any interested developer.

Quantum GIS would at times crash especially when a lot of data is loaded. It would simply say it has to close down. In addition digitizing was not very easy using Quantum GIS. These are very minor draw backs as compared to the cost of proprietary software, especially considering that it is not clear whether the difficulties are due to software deficiencies or due to inadequate user training.

Proprietary GIS software is quite expensive especially for cash strapped third world economies and small to medium organizations (Christopher, 2006). Open GIS

software provides excellent alternatives to their GIS needs. The budgets for purchasing one proprietary solution for these organizations would by far surpass the amount required to train internal staff on open source GIS software use.

5.0   Conclusion and Recommendations
5.1   Conclusion

The Internet and World Wide Web is gaining popularity as the revolutionary medium of communication for the new millennium. Thus the integration of Internet and GIS for information dissemination has provided a new opportunity for GIS Industries to exploit.

Map data will normally be transmitted to a Web client in standard HTML formats. This implies that they can be accessed through any Web browser.

Furthermore the use of Open Source GIS software application makes the software available to people who would otherwise not have afforded it. Selling real estate in Kenya is becoming an important business. It is because of its vital importance that creative and sustainable ways to keep this profitable industry on track must be found. Users must not only adjust with what is on the market now but find new ways to promote what we already have in our hands. Open source software such as Quantum GIS and Mapguide open source are free platforms that provide facilities that can be used for many applications. Putting the system on the web means that the user does not have to possess any special software to display it. It is as simple as opening a web page.

With that incredible quality users can reach more people and let them know about

their products; in this particular case plots and houses for rent. The Internet as a search tool does, in fact, reduce search costs. The Web allows buyers to quickly and cheaply locate and learn about houses and plots on the market. This information can then be used to identify those properties that are most likely to meet their needs. The main focus of the system is to provide the potential buyers with enough information that makes them feel as if they have already been to the property. Furthermore it offers the customer additional information about the property which may be the enticement needed to make the purchase/rent instead of only relying on the appearance of the property.

5.2   Recommendations

This system can be improved to cover the whole city or the whole country or even the whole world. Such a system would then allow buyers and sellers all over the

world to interact, buy and sell property from anywhere in the world. The integration of the system with Google maps would assist to provide a more natural experience to customers. Just like the CityCribs.com for New York real estate system which integrates Google maps with its real estate database to provide its users with a rich and enjoyable search experience. In addition the application of tool tips can be improved further by including "mash-ups" to allow the home/plot seeker to search for plots and homes on a map (complete with property information),then link to receive full details for each listing.

As regards apartments for rent, the system can be improved by including virtual tours like the Honduras real estate system which allow the user some preview of the house interior for better decision making. Thus, in order to keep the cost down, there is need to investigate the open source or other cheap software alternatives to allow for the inclusion of desired features, without making the system too expensive for real estate agents in Kenya. In addition, a user needs assessment would go a long way to making the system more responsive to the specific user needs in this industry.

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