Usability of Online maps

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ABSTRACT
Maps have been in paper based format for many centuries. With the great invention of internet, map, has been developed and evolved into digitalized online GIS (Geographic Information System). Many online map websites are getting much easier to use for common users, even the users do not have strong computer and geographic knowledge. When travelling to an unfamiliar place, even just a suburb nearby, the first thing that people will do, perhaps, is to go to maps.google.com to some search of the place. Base on the recent success, many popular online map websites start to build business module to be integrated on the top of the map. It seems that there is a bright future for the development of online GIS.

Keywords
GIS, usability, geo-visualization.

INTRODUCTION

In this paper, firstly, an interdiction of current state of online map websites will be presented to help audiences to have basic image for the online GIS. Then the paper will discuss three different usability aspects from online GIS namely: universal accessibility, virtual environment, and navigation and GIS agent. Finally some future work related to online GIS will be presented.

THE CURRENT STATE OF ONLINE GIS

Using maps is a very common activity in today's world, especially travelling in a new and unknown area. When asking a question about how many cars are with a printed map or virtual map like navigator onboard, the answer might be very positive that most cars are with maps onboard. There is a very long history for human beings to make and use maps. "Celestial maps were found on the wall of the Lascaux caves in France. These could date as far back as 16,500 B.C.E. And the first known from-above map of a terrestrial area is another wall painting showing an area in Turkey, circa 6,500 B.C.E"[1]. Maps in paper based format or similar materials do not have too much advancements compared with their ancestors and relatives during the era of voyage. The advantages they have are the more colorful printing, the use of new material like synthetic material with stronger fibers, and the higher degree of accuracy. This situation has been changed too much until the appearance of integrated GIS. Than look at the general definition [2] for GIS, "digital information system whose records are somehow geographically referenced", that is very clear that GIS is a digitalized and systemized maps system. With the helps from database, maps are integrated and transformed into GIS. GIS aims "not only to draw not only a picture of a physical area as seen from space, but also to associate geographic data with other information types"[1].

Nowadays, GIS has been no long be considered for scientific and professional purposes only. Many GIS, especially online map websites, are providing more accessibility for the general public. Major search engines and portal sites, such as Google, Yahoo!, Ask Jeeves, and MSN, provide local search services [1]. Based on the recent success on those local search services, many online map website start thinking to build new module to build and integrate business on the top of the map. Like trademe.co.nz, it is the largest online e-commerce website in New Zealand. On some exchange categories, like searching a house to rent or buying a house, they do not only provide details of the estate but also a map online to indicate the location and general view of the area which the estate is located. So the people who are interested in the estate can have a direct impression of the location and the area or the community surrounds the estate.

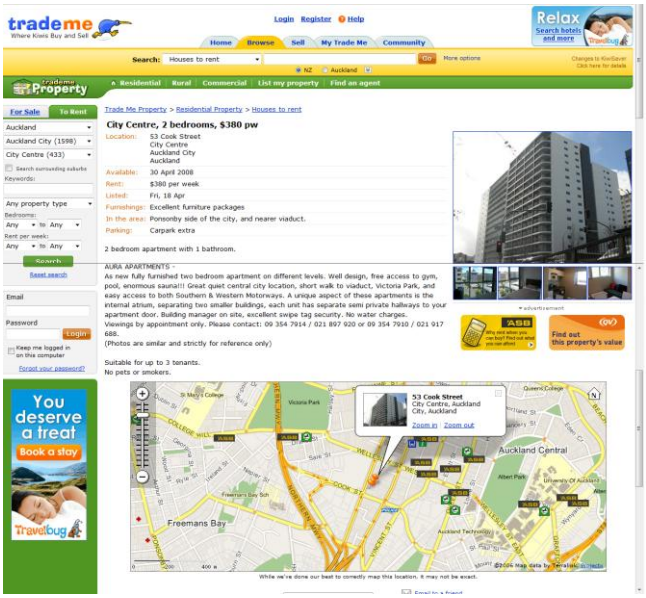

Figure 1.Sample house searching page from trademe.co.nz.

In order to increase the market portion, many big map websites have been developed a series of API or plug-in for third party companies or websites to use their local search service. JavaScript is the common technology that has been used for the implementation of those similar mapping system's API.

When using those big four map sites: Google Maps, Yahoo! Maps, MapQuest.com, and Virtual Earth; they all have the some common features [1] :

- Click-and-drag interface for navigation.
- Driving direction between two points.
- Zoom ability, ranging from planet to street level re-solution.
- Integration with a local business database, so a visitor can, for example, find and map all Chinese restaurants in a given neighborhood.
- Satellite view, showing landscape photographs from overhead (some pictures are actually taken from airplane); and
- Access to several layer of information, such as roads, traffic, and locations of sponsor storefront.

At current stage, those big map sites do not just focus on building advanced API and plug-in. They also move on to develop three-dimensional environment for presenting 3D map online.

As the study case for this report, Google Maps will be selected as the object to join the research to help to explore some of the issues from the usability aspect. "Launching of Google Maps (beta version: February 2005; alpha version: October 2005) started a new era of embedding geospatial information within web sites" [3]. Google, as the leading search engine in the internet industry, bought Keyhole in October 2004, to develop Google Maps and Google Earth the next year[1].

UESBILITY AND ONLINE MAPS

"Usability" seems to be a very technical term and too broad to be understand. In fact, Usability refers to "extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified content of use" [4]. When refer to the online map products that will be a simple conclusion: whether the map is easy to use or not. As the biggest part of the GIS, how to implement the GeoVisualization is a very crucial. There is a group of cognitive and usability Issues that have impact on whether the product is with good usability or not.

UESBILITY ISSUES RELATED TO ONLINE MAPS

From this section, three different identified issues come from usability aspect of GIS will be discussed which includes: universal accessibility, virtual environment, navigation and GIS agent.

Universal accessibility

As Shneiderman[5] indicated the term universal access is "usually linked to the US Communications Act of 1934 covering telephone, telegraph, and radio services. It sought to ensure adequate facilities at reasonable chares, especially in rural areas and prevent discrimination on the basis of race, color, religion, national origin, or sex."[5]. It is obvious that the origin of using the term of "universal access" is not from computer industry. Now the term is widely used IT field. And it has been used to describe "a system that is designed to support the empowerment of "everyday" experts, citizens and both casual and intensive users of contemporary information technology"[6]. However, with the increasing of level of complexity and the continuous expending scale, as Shaneiderman[5] pointed out that the greater complexity of computing services means that access is not sufficient to ensure success usage.

Back to Google Maps case, Google Maps have done very well on the basic level to meet the requirement from universal accessibility. The company holds their services online as web services available form all user who have accessibility to the internet. Using internet as a media can be considered as an advancement of the development of GIS. It used to be a long period of time that GIS was implemented and stored on the hard disk or CD drive. Limit accessibility was provided at that stage and regular and rapid updating the embedded geographic information such as expanding or updating maps, and renewing related data, seems to be a hard job except to release a whole new version of GIS. "Things are changing so fast". This is a complaint from everyday ordinary people, especially people living in the developing courtiers with high economic grow. New high way, new bridge, new public construction, and new suburb, keep presenting themselves in front of the public. Centralized design of this kind of online mapping website ensures that they will be able to update their geographic information database very easily and quickly. Although, many people still murmur at Google Maps not to update the maps with the speed as they are expecting, but generally, Google Maps and similar online mapping websites have done well on this level compared with non-online mapping website GIS.

When standing in a higher level to explore the universal accessibility of online GIS, human factors are playing a very important role which has impact on the adjustment of good accessibility or not. Human factors are so called "difference between group and individual" and can be indentified mainly as: sex, age, culture and sensory disabilities[7]. Sex and age, those two factors can be considered to act together to characterize individual. Law, Pellegrino, and Hunt[8] conducted experiments which came up with conclusion that males and females have different performance when handling dynamic spatial reasoning task. For age, it is obvious that adults are acting very differently from children. Sensory disabilities also needed to be considered. Since color is widely used in Geovisialization, like describing the border and area of the territory, and people with potential visual impairment such as color blindness will have lower accessibility to read the maps. So such methods should be carefully tested. While thinking about culture aspect, two things should be considered and incorporated very carefully into GIS: linguistic information

and the interpretation of iconic symbols. Particularly, iconic symbols are effective tools for people to give the rein to their strength of association. At the famous and public-known location, like airport, ferry, or bus station, different kinds of icons which describe the transportation are put to symbolize the functionality of the building or place. For example, putting a mail icon at the point of the location is for representing a post office is located on that place. However, the use of iconic symbol should be aware of users' cultural background, for instant, color green may suggest water more effectively than blue does in some cultures[7] and color red means good luck in the tradition of some Asian countries while this color means hazard in the western world. Google maps provide different levels of maps of the global. On the higher level, Google maps seem to have no problem on displaying linguistic information. On the country or area, if English is no an official language, local language will be the main annotation for the name of the place and English will be supplement. But there is not always a case. Under the limit and restriction of system scale and database system, it is very hard to implement and integrate geographic information for every village, every city, and every single territory. Some areas do not have geographic information in details which leads a huge empty space on some area of Google Maps. And some of areas only have local official language annotate the place names. That will be a problem to provide good universal accessibility.

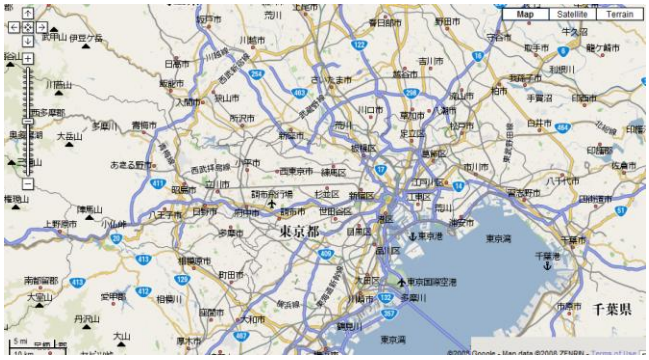

Figure 2.Map of TOKOY, JAPAN from Google Maps

On this area, all place names are marked by using Japanese. It is very hard for non Japanese speaker to read this map. Similar problems happened on many areas on Google Maps. The only solution for this kind of issue is to spend more resource to collect more geographic information and translate into different languages to provide a multiple language environment for user to alter setting fit the needs and user language requirement.

Virtual environment

The word, "virtual environment" has many different phrases such as virtual worlds, virtual landscapes, and virtual reality. One of the goals of the GIS to achieve is to build a virtual environment to make users to feel the environment surrounding them is closed to the real environment. Some users may have previous experiences of within the actual environment, and the others may not. So the simulation of real environment should be carefully considered so the factors within virtual environment should share with the real environment. People[9] divided the factors into four groups associated with: immersion, interactivity, information intensity, and intelligence of objects.

Immersion, as the definition from Witmer and Singer[10], "is a psychological state characterized perceiving oneself to be enveloped by, included in, and interacting with an environment". It is a conceptual topic to describe how the degree of freedom that users can use their variety of senses to feel and access the environment. Online GIS like Google Maps can only provide non immersive desktop environment. Users can only use vision to access the information from GIS. Due to the limitation of information technologies, system can not provide methods for use to access the information by the other senses except vision. Google Maps seems to be having same problem to just provide information by vision access only.

When looking at interactivity aspect, "one concern with interactivity is developing methods to assist user in navigating and maintaining orientation" in GeoVEs[7]. A navigation tool has been developed by Google Maps to help user to do navigating and maintaining orientation shown as the tool in figure 3.

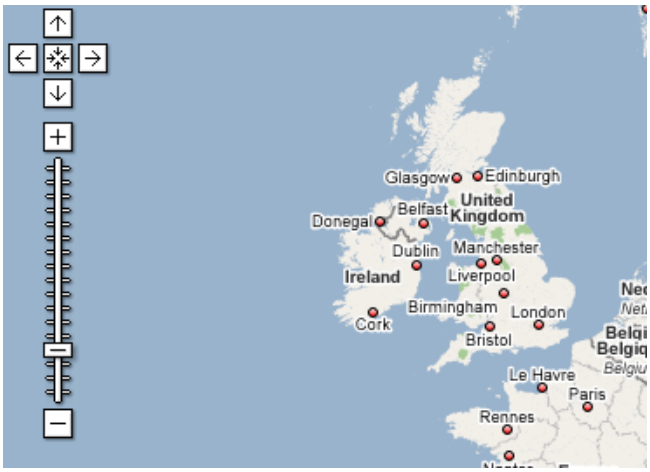

Figure 3.Navigation tool from Google Maps

A group of buttons with four directions on each button and one button on the center which tells user that this button is to "back to last result" to allow user to navigate back to last search result or default setting (USA). This tool is actually doing good job. However, Google Maps can not provide interactivity like Google Earth to allow user to rotate the map so the map always orientate to the north. Possible solution for the rotation function for Google Maps is to reprocess map image to have 90 degree, 180 degree, 270 degree map image respectively for user to chose. However, that will be a hard job for the embedded database system. It

needs massive storage and process speed to process the query and the request to rotate the result map.

Information intensity is the term to be used to describe combining the information in details from different layers together in virtual environment. Google Maps provides three different view models: normal map, satellite imagery, and map with terrain. On the satellite imagery model, user can chose to put an information layer on the top of the result map to show the place names. On normal map model, when user uses the wheel of the mouse device to decrease the altitude or user the altitude rolling bar to get into different level of result map, more place names will be appeared because the focuses area are getting more specific and more information layers are put on the top. Large infrastructures like state high way, airport, and seaport will be the primary objects to be put on the layer to be displayed. Then down to street level, the level of information intensity increase and user can see the name of the street very clearly. And meanwhile, some layers which related to traffic control like one way driving direction are put on the result map. Unfortunately, Google Maps does not provide more details for some places on the bottom level layer such as hospitals, post offices, and police stations and so on. So the bottom layer of result map does not have good information intension. It is just a driving map. On satellite imagery model, when user go to street level with show label option on, the map seems to be too mess. Some street name labels are overlapped with the street and the street are totally covered. So it seems to very hard to keep balance between displaying the real image of the street and the name label of the street on this model.

Then as the last factor of virtual environment, intelligence of objects, "raise some appealing possibilities for assisting users in interpreting GeoVEs"[7]. Since the learnability is one of the perspectives of usability for GIS, providing methods for actual user to learn how to adapt the system is the task for intelligent agents. So intelligent agent is just like a tutor that helping user to do navigation and understand the information retrieved from the GIS system. Google Maps is doing not a bad job on this. They provide

Figure 3.Navigation tool from Google Maps

sample queries for user to help them to learn three different ways to retrieve information from the system and search a place that the user is wanting to. When the user is trying to click one of the sample queries, it can guide the user to get to place. So user actually finished one search action and gained some experiences on how to search a place. But there is a small problem here. When user first use this agent to learn how to use the system, and they move cursor over one of the sample links. There is no message to tell user can "click here to try to find this place". And it seems to provide not enough motivation for user to do learning action.

In general, when not thinking the limitations which come from the current technologies, as a web application based on 2D desktop environment, Google Maps is providing high quality virtual environment to help users to use GIS online.

Navigation and GIS agent

The main objective for common users to use online GIS is to find the place on the map. So providing methods for user to navigate and find a location is very important. Like a GIS have good universal accessibility which can meet needs and requirement from majority users and good geographic virtual environment which can simulate a real world environment, but very bad design on navigation. This GIS can be considered as an unusable system which the user can the place and navigate the result map to that location. There are two important metaphors for GIS which are "navigation to locate facts, image and other relevant information; and narration to retrieve data result set using narratives of information with key words" [7].

For navigation, many online map web sites have been developed very similar tools and methods for assisting user to do navigation. Click-and-drag is very common feature which can be found on those map websites such as Google Maps, Yahoo! Maps, and so on. The result map has been divided into different levels according to different altitude. Different levels will have different levels of details information layer to present information. On the same level result map, users can click-and-drag the map so the user will have not only x-axis and y-axis directions navigation but also multiple directions navigation. Also, a tool similar to what has been shown on figure 3 is developed to provide another simple tool to allow user to just click the four buttons to do navigation. But this tool just provides navigation for small distance. If user wants to do navigation for long distance, user has to click the button for several times to retrieve the system to have new result map. While users want to zoom in/out the map, they either increase the altitude or decrease the altitude by move the rolling bar up or down. Many online maps seem to have no problem in navigation since they consider navigation is very important.

Then as the others important metaphor, search engine is other key point. People will find themselves feeling lost when facing huge amount of data. Some people analyzed the reason as "the web provide accessibility for general public to access huge stores of information, much of it with

geospatial referencing, thus web-based geovisualzation has potential to engulf users with huge amount of information which is unorganized"[6]. Finding and locating a single place on the earth could be very easy and could be very hard. So building a "data filter" to have user to narrow down the result set. Being a leader of the search engine on the internet, Google Maps builds up a search filter to allow user to search a place by address, by business name or by position. It is very hard to conduct a test on large amount of search query to exam the usability of the data filter. But it seems that Google Maps data filter efficient facility to the user. Especially, for the business search, they provide two filters to search the business name and location which is good for minimize the scope.

In general, the goal of navigation is to provide high accuracy with simple action performed by user and also the accuracy is the objective for the "data filter". For Google Maps case, it seems that it does not have too many issues on navigation and GIS agent and very closer to the needs from users.

CONCLUSION

At all what has been discussed above is not to try to setup rules or standards to force the online maps websites to be implemented in similar ways. It is to explore the usability aspects of online map websites. In general, public would like to see an online GIS to be developed as a system with a good universal accessibility, similar virtual environment that closer to the real environment, and usable navigation tool and search data filters. Some of the usability issues come from the limitation of current technology while the others come from the design. With the appearance of advanced embedded database system and displaying technology, it is sure that online mapping websites can go further on the better way to provide higher quality services for the general public.

FURTURE WORK

Form personal opinion, it would be possible to provide 3D geographic environment on 2D website-based application. That will be a huge break through. Although, there are some real desktop GIS application running under 3D environment, but trying to build the system on the web, means a huge amount of development to redo the modeling and setup new theory because the one applied for 3D desktop environment is only suitable for application on desktop. However, there is nothing impossible. Especially in the IT filed, new technologies are coming with the speed which is unpredictable. The time to have 3D Google Maps is not very far away.

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