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Location aware applications for smart cities with Google maps and GIS tools

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***Abstract*—The release of internet mapping API like Google maps had changed the way many location aware systems works, this paper will look into how location visualization tools can make use of this new way in providing location service.**

With the emergence of wireless broadband internet in increasing number of cities, digital cities are being developed all over the world where public services could be hosted for users with a fast connection. As part of an effort to enhance a digital city, we apply visualization tools to a real estate system as a study into the usefulness of Google maps and GIS. The result will probably be used to provide more services which will in turn form a better featured digital city.

Location Aware Real estate agent (LARE), a real estate agent which uses the latest technology in GIS and internet mapping systems to become a very powerful agent based system. LARE uses different technologies like 3-d modeling with VRML, local maps with GIS shapefiles, and even online maps with Google maps. Thus it provides a map view of location with a GPS and mobile device, while providing geographical updates or even digital interactivity.

***Index Terms*— Geographic information systems, Internet, Programming, Real estate, Smart cities.**

I. Introduction

As technology advances, larger transfer of information are becoming more feasible, a lot of opportunity for smart city living is available as providers could send geographical information for real estate systems or general public service or traffic conditions.

In the United States, different attempts to create digital cities environments are already in place. Some had created online portals for their state while others attempts to support wireless internet for the whole urban regions. The city of Cerritos in California has recently become the first city in the U.S. to attempt going completely wireless. Other municipalities around the world had been watching to see how well this experiment in bringing low-cost broadband throughout a small city works out [2]. Meanwhile, other states like Boston and New York are starting slowly to provide increasing number of wireless hotspots in different urban areas.

With such communication infrastructure, Information and services can be easily searched. There become a need for visualization tools to enable users to view such information in a smarter method, much attention is now diverted on how information and services are explained and how are they displayed to users.

One of the possible application for location visualization tool is a property system, the property market is one of the hottest investment topics in today's society in which the need for location visualization tools are always present in order to allow digital interactivity and smarter living.

The recent APIs provided by Google maps will soon create a major change to the way programmers work for their location systems. There are already some work done with Google maps and they will be discussed in the later chapters. With the emergence of fast broadband internet available commonly in most countries, online mapping became a possibility over current proprietary mapping formats.

Location-Aware Real Estate (LARE) project is a joint venture between the Heritage Pacific property development company and the Australian CRC for Interaction Design (ACID). The aim of the project is to research and develop a hand-held, location-tracked device enabled with a program which allows for the viewing (and configuration) of 3D models of properties (land and any buildings thereon) in the user's current vicinity. Information regarding properties of interest should also be made available to the user on request.

II. GPS and Online Maps

Current location aware systems in the market involves a GPS antenna and it proprietary software, this means that the map files are only usable by their system. Information which needs to be displayed requires proprietary software to update the mapping information or location information. GPS works by obtaining signals from at least 3 satellites and computing the geo coordinates with the signals are received, the users are then able to know where they are in terms of longitude and latitude.

Google Inc has released its APIs for their mapping services in June 2005 [4]. By providing free internet mapping services, Google allows developers to display geographical maps in their systems. With ease of usage, high interactivity and good freedom of control over the maps, Google maps have revolutionized a lot of aspects in mapping systems.

Being a dedicated mapping provider, these online mapping services are brought to consumers professionally while providing an open source environment, Location aware systems could then concentrate fully on providing intended service to their users. The emergence of other online mapping services by Yahoo and Msn only shows how much Google maps have impacted the way we view on online maps.

There are increasing number of usage on these free online mapping service, hundreds of mashups overlay maps with everything from such practical information as gas station prices, hurricane movements, hot springs sites and crime statistics to the more entertaining if not frivolous, including UFO sightings and movie locations [1].

The emergence of internet mappings and the available technology which allows users to consume services online even wirelessly has attracted much attention. With so much advantages and potential savings, there are a lot of opportunities and reasons to develop services with general mapping providers.

III. LOCATION VISUALIZATION TOOLS

There are several visualization tools already available, services like location detection, real estate systems or even vehicle tracking systems are some general uses for such visualization tools.

Location visualization tools offers user a very simple and efficient way of obtain information for different resources. With mapping systems, location of a resource can be easily obtained and suggestions on how to arrive there are also possible. Technology on location visualization tools with mapping have improved at a tremendous pace, so much that mappings have already migrated from static to dynamic maps and now online maps.

A. *Terrafly Real-estate [5]*

Terrafly Real-estate is a project by the High Performance Database Research Center in the Florida International University. It has successfully created a web based interface where users could search for a map of an area, and they could access property information from the site.

The real-estate service provides a very simple and lean method of obtaining information like the price, and size. But there is no provision for any 3-d view of the building or the surrounding area. Part of the research goals aim to overcome this issue by employing a three dimensional rendering tool where users are able to obtain information and even view a three dimensional view of the area. Terrafly also employs aerial images for mapping, which means that maps needs to be updated through a more inefficient process.

Figure 1: Terrafly real estate

B. *Hyper map atlas [8]*

StrataVarious, Inc. had launched a similar location visualization tool for Boston using the Google Maps™ API. The Hyper Map Atlas enables a fuller view of the surroundings. From the patented "clickable key" users can select multiple geographic features and collect them in their personal key list.

StrataVarious is one of the few researching company to jump into Google maps as a new location visualizing tool and they have done well to provide general information like landmarks.

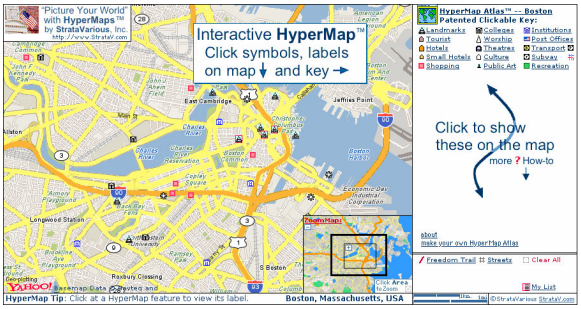

Figure 2: The Hyper Map Atlas

Similarly to Terrafly real estate systems, the lack of three dimensional environments reduces the impact of the service provided.

C. *US Real estate pro [10]*

USFlashmaps used a different approach towards providing location information, as they make use of flash to display the maps instead. Flash maps has a powerful framework to understand your real estate listing database, and plot the locations on the map using longitude/latitude geographic coordinates, zip codes, or simply city names.

USFlashmaps had used a proprietary mapping system which might cause maintainability problems when updating or increased working area arises, a part of the research goals is to reduce reliance on proprietary mapping systems and allow services provided by dedicated providers to display the maps.

This will ensure quality and maintainability of the mapping systems used.

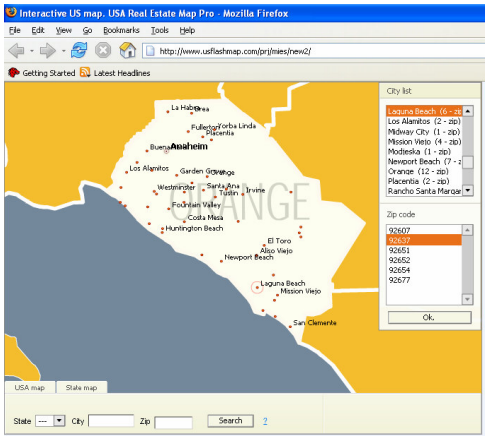

Figure 3: Real estate pro example

D. *Activemap [7]*

ACTIVEMAP is another example visualization Tool that enables users to gain greater awareness of the location of people in their workplace environment, increasing each person's ability to seek out colleagues for informal, face-to-face interactions.

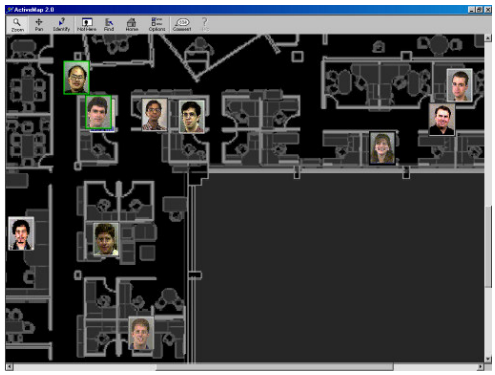

Figure 4: Active maps

ACTIVEMAP has managed to produce location visualization as another form of service which is very much localized as in comparison to the research services available above.

IV. RESEARCH GOALS

We intend to explore into the development of a location aware visualization service provider in a smart city living environment, it is meant to help users in a smart city to discover resources or information in their surrounding area.

In order to create such environment, a prototype system is being created, Location Aware Real Estate (LARE) system is to become a prototype service provider for real estate agents and clients in this scenario and the resource in this case will be the properties for rental or sale.

With Google maps API and LARE's ability to make use of such technology, we are able to gain an advantage over traditional systems mentioned in chapter II. LARE will also provide a feature which most real estate lacks in, which is a 3-d modeling architecture of buildings or estates. Property investors always face the problem in lack of feel for the actual look of the whole house. LARE employs VRML for this purpose, the VRML technology will also be discussed in the later chapters.

Lastly, LARE will also recognize the need for remote information, where internet connection might not be available or very slow. LARE should have the ability to store GIS information remotely just like the traditional methods of location visualization tools. As we have discussed above, having proprietary databases will hinder growth, complexes maintenance and increase cost of systems. LARE will aim to reduce such problem by utilizing shapefiles as a GIS datatype. Like VRMl, shapefiles will be mentioned in the later chapters.

V. LARE ARCHITECTURE

The following is a diagram depicting the high level systems architecture. A satellite navigation system GPS used to determine one's precise location almost anywhere on Earth or in Earth orbit, it also provides a highly accurate time reference and this service can be used by anyone for free. GPS receivers that plug into these devices can also be purchased if they don't already have one built-in.

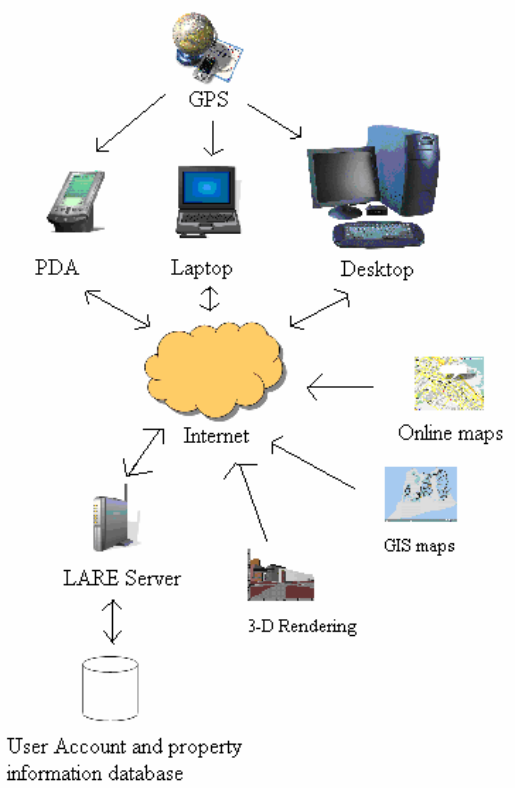

Figure 5: High level architecture of LARE

Satellite navigation information is then being retrieved by clients using laptops, computer workstations or PDAs (Personal Digital Assistants). In which an application agent will use the navigation information to obtain relevant GIS information from the program.

Clients will be able to access to the Internet to access the information stored on a remote server. The manner in which access is enabled is determined by the user – whether it's via a telephone line, wirelessly or even GPRS for example.

A secure web server can be used to manage connections and access to the backend databases. It may also host various online services accessible via a standard web browser (e.g. a website allowing searches to be performed online, or account details to be viewed and updated). Lastly, it should also handle bank transactions for clients who want to purchase.

VI. LARE CLIENT

This paper aims to look into the usability of latest technology in real estate applications, as this research also considers portability issues and the problem of limited processing capability and power. These problems are especially true for users with PDAs, and thus it is very important that a proper data format is chosen for rendering to provide a visualization tool.

There are 3 main components in this agent application, the Google maps VRML and GIS shapefiles. LARE integrates these technologies to form a package for clients to access real estate information. These data formats are carefully chosen after comparison with different alternatives because not only are they better received in the industry, they are more efficient in data transfers and provide greater processing efficiency.

These decisions are very important as they will affect the way the portable versions of LARE is run, details in pocket version of LARE is found in the later chapter

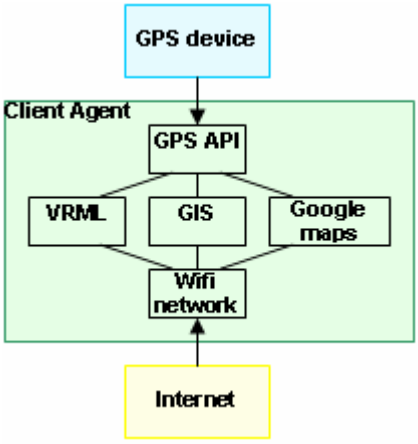

Figure 6: Client architecture

A. *Google Maps*

LARE uses Google maps to provide mapping information for clients. Google maps are being employed over Yahoo and Msn not only because it is the pioneer in providing this service, Google is also slightly more powerful in terms of developer features. [9]

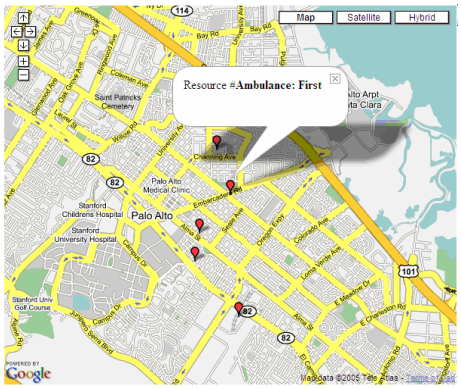

Figure 7: Google maps

B. *VRML*

LARE makes use of Cortona viewer for providing 3-dimensional information of the landscape and even buildings themselves. VRML is an open, platform-independent file format for 3-D graphics on the Web. It encodes computer-generated graphics in a way that makes them easily transported across the network [11].

Users are able to display these simulated virtual reality 3-D "environments" or "worlds", where they are able to perform different types of movements or 'tour' around the house or estate. This provides the look and feel of the resource being selected, the method of display brings more realism into information and provide an understanding of the environment which text cannot replace. The example below shows LARE displaying a surrounding estate in a property.

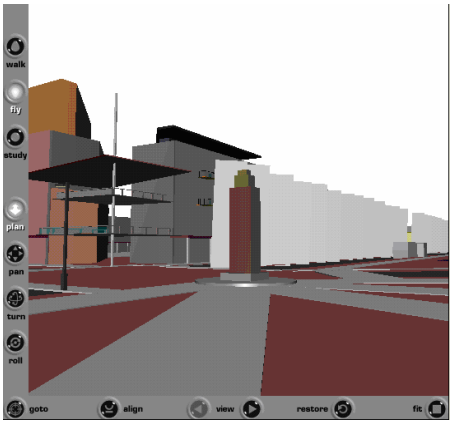

Figure 8: Cortona VRML

C. *GIS*

LARE employs the use of ESRI shapefiles to render any offline GIS mappings, GIS data can take many forms but shapefiles is chosen because it appears to be the most popular

format commonly used for GIS geo-location visualization.

One of the main advantages of shapefiles are that they do not have the processing overhead of a topological data structure, they have advantages over other data sources such as faster drawing speed and edit ability. Shapefiles handle single features that overlap or that is noncontiguous. They also typically require less disk space and are easier to read and write [3].

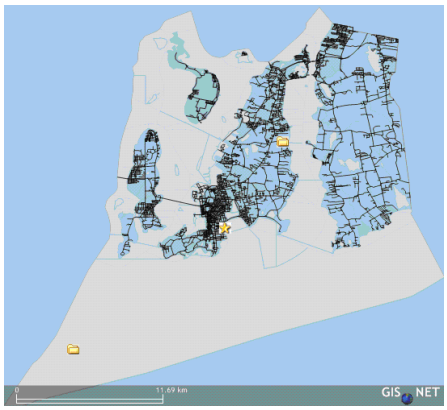

Figure 9: ESRI shapefiles in GIS

D. *GPS integration*

Mobile user's geo-location needs to be obtained from GPS connected, other methods like wireless network triangulation are also possible to provide geo-coordinates. LARE uses Geoframeworks API [6] which allows the system to obtain information from any GPS device, and this ensures that clients are able to move around to the site itself.

E. *LARE- desktop/laptop version*

As mentioned in one of the research goals above, this paper aims to research different aspects of a real estate as part of a digital cities environment. A prototype is being made to test the applicability of the research result.

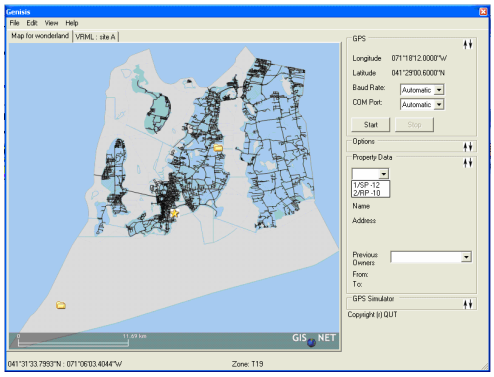

Figure 10: The desktop/laptop version of LARE.

The desktop version of LARE has proved to be very successful, the programs do not take up too much resource as it uses GIS shapefiles to render the information for GIS and VRML for 3-d rendering graphics. Google maps do not use up much resources but it requires an internet connection.

VII. PORTABILITY FROM DESKTOP TO PPC

As LARE needs to include users on the move, some users might not have more powerful machines like a desktop or a notebook computer. Provisions are made to ensure the use of a PDA is possible.

The greatest challenge in 'pocket-LARE' is performance over portability. Personal digital assistants are known to be very small and ultra portable, but PDAs are also weaker in computing power. Graphics rendering of location mapping information can prove to be a very big challenge. It is because of these constraints where this research got to look into, and thus choose a proper format which is very portable for internet transfer and yet not processor consuming.

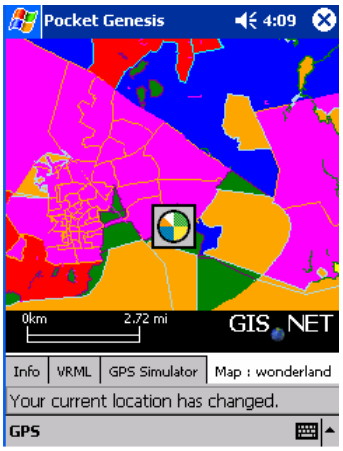

Figure 11: LARE displaying GIS in Pocket PC

On top of GIS rendering, LARE also need to include 3-D rendering without causing the PDA to stall. LARE employs the use of pocket cortona to display its 3-d rendering VRMLs.

Figure 12: LARE displaying VRML

VIII. Conclusion

We have successfully merged different technologies like GPS, VRML, GIS and the internet into a common framework. Users are able to obtain real estate information from the internet. This information is displayed graphically in 3-d modeling and also map format.

There are some location visualization systems being proposed which uses different methods of obtaining location data, most of them don't make use of online maps or 3-d rendering mechanisms for visualization. As technology improves and progress, better systems can be looked into and researched to provide better service.

The release of internet map APIS like Google maps have changed the way location systems work in terms of providing GIS information, LARE is a system to take advantage of the services given by Google maps to provide such improvement.

From LARE, we are able to use different technologies like GPS, GIS shapefiles, VRML models and online Google maps to create a location visualization tool for smarter living. Its framework could also be used to create a bigger picture, to create a digital city in which different services could be provided with GIS information.

LARE also has an online version for the PDA which can enhance it to be part of a mobile digital cities environment. Although we have researched into using latest technologies to create a real estate system, the whole work done is still a prototype application. More services can be added into LARE and we can better improve the controls of the Google maps.

Acknowledgment

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