THE USE OF VIRTUAL REALITY IN VISUALIZING LAND PROPERTY

J. A. Quaye-Ballard
Department of Geomatic Engineering,
Faculty of Civil and Geomatic Engineering,
Kwame Nkrumah University of Science & Technology (KNUST), Kumasi, Ghana.

ABSTRACT
The paper discusses virtual reality as a visualization tool such that users could interact with a developed application medium, as if they are inside the virtual environment presenting the application. Virtual reality as a presentational medium offers different views of reality which real estate agents could use to visualize estate properties. In this paper the virtual application (prototype) was designed using ArcGIS 8.2, Internet Space Builder (ISB) and Image Editing software. Interviews and responses to questionnaires used as inputs to developing the application are highlighted. The developed application involving 3D virtual environment was achieved by exporting an extruded two and half dimensional (2½ D) cube-like shapes of cadastral parcel boundaries into Virtual Reality Modelling Language (VRML). The developed application was then tested. The intent of developing the 3D virtual application (prototype) is to help clients' of real estate agents to visualize properties in 3D when they visit the real estate agents.

Keywords: *Visualization, Virtual reality, Maps, Real Estate Agent*

INTRODUCTION
Maps are no longer the final products as they used to be, for instance the paper maps, which functioned and still function, as a medium for storage and presentation of spatial data Kraak and Ormeling, 1996). On-screen maps and its corresponding database have changed these functionalities. The knowledge of database technology and computer graphic techniques have resulted in new and alternative presentation options such as the three-dimensional (3D) and animated maps. According to Köbben (2002), 'a map is said to be three-dimensional when it contains stimuli which make the map user perceive its contents as three-dimensional'. Köbben further added that to see in 3D involved *physiological* (that is, involving human visual stimuli to see real depth; for example, focussing of the eyes and turning of the eye towards the object) and *psychological* depth cues (that is, involving graphical techniques to 'fool the eye'; for example, shading and perspective). In this paper, the

visual stimuli are the extruded footprints of two-dimensional (2D) maps into 3D model with images of the properties textured onto the 3D model, which was then visualized in Virtual Reality Modelling Language (VRML) to give a realistic 3D desktop virtual view. Desktop virtual reality which offers 3D display of a particular environment uses VRML to create and manipulate the virtual displayed environments (Rhyne, 1999).

The paper aims at developing virtual environment to help clients of real estate agents to visualize land properties in their offices. This is because Virtual reality brings the promise of a much more comprehensive way of visualizing data. The user within the 3D environment can directly interact with the displayed data (Verbree *et al*, 1999).

According to Koehne and Howard (2001), the ease of access to property information provides benefits to the general public and business community including real estate agents, conveyancers, valuers, surveyors and others by placing information at users' fingertips. This simply means that users of land property who are the real estate agents, conveyancers, valuers, surveyors as well as the landowners of the general public need a visualization tool to help in visualizing land properties.

The real estate agent is the person who is authorized to act as an agent for the sale of land and buildings (Macmillan and McGraw-Hill, 1993). Real estate agents assist in the process of buying and selling real estate for their clients. Real estate agents' current role in visualizing property is through the means of hardcopy pictures or static pictures or video images. The pictures of properties are shown when clients visit their offices. The computers are mostly used to generate lists of properties for sale, their location and description. It is also used as a computer network to link digital images they have in their offices to the Web and to other organizing bodies. Mostly, these organizing bodies collect all the images and information on properties from registered real estate agents, and then publish these images and information in their magazines. The computers are not used in visualizing properties which real estate agents have for sale in their offices. However, the computers sometimes are used to playback video images without involving human interactions. It is against this background that the work was done by developing a system for the real estate agents to help their clients visualize properties and its surroundings on the computer using virtual reality. To conduct the work, an investigation of real estate agents' requirements for visualizing property on the computer in their offices was carried out.

MATERIALS AND METHODS

The procedure used for the study included: interviews and questionnaires; field observations and measurements; extruding 2D cadastral map using ArcGIS 8.2 software; exporting the extruded 2½D boundaries into VRML for development of the 3D virtual environment and texturing of images using the Internet Space Builder (ISB) software; and usability testing.

Interviews were conducted with few real estate agents for the basic inputs for the virtual application. That is, out of the twenty-two real estate agents contacted, four responded for the interviewing and questioning. The designs of the questionnaire for the interviews were based on the objective (that is, real estate agent requirements of visualizing property) of the interview, determination of the target group and developing well-structured questions. The questionnaire used consists of closed-ended questions in which the questions are 'structured' and 'totally structured' types. 'Structured' types consisted of questions that are determined and the interviewer codes responses as they are given. 'Totally structured' types consisted of questions that the coding is predetermined and the respondent presented with alternatives for the questions so that the phrasing of the responses is structured. These types of questions were chosen for easy coding and easy analysis of respondents' feedback.

Field Observations and Measurements were carried out by taking photographs and measuring heights of buildings respectively.

Photographs: Photographs of respective buildings were taken using Sony Digital Mavica Quick Access FD Drive 2X camera. The contrast, sharpness, brightness and size of the images were edited with Adobe Photoshop 6.0 image editing software.

Measurement of height of buildings: The measurement of the height of buildings was done using the Suunto Altimeter PM-5. This instrument provided an easy means of collecting height of buildings without actually occupying the building. Angular measurements with the Suunto Altimeter PM-5 were taken by sighting top of the building and the readings noted on both the angular and the percentage scale. Another sighting taken at foot of the building and the readings taken on both the angular and the percentage scale.

Pacing (where 1 pace = 0.7 m) was used for the base measurements instead of stretching tapes from base of building to the position where angular measurements were taken. Pacing which is a less sophisticated method of measuring distance was used because a precise horizontal distance measurement was not needed for the study. This base measurement was used in calculating the height of the building (Figure 1).

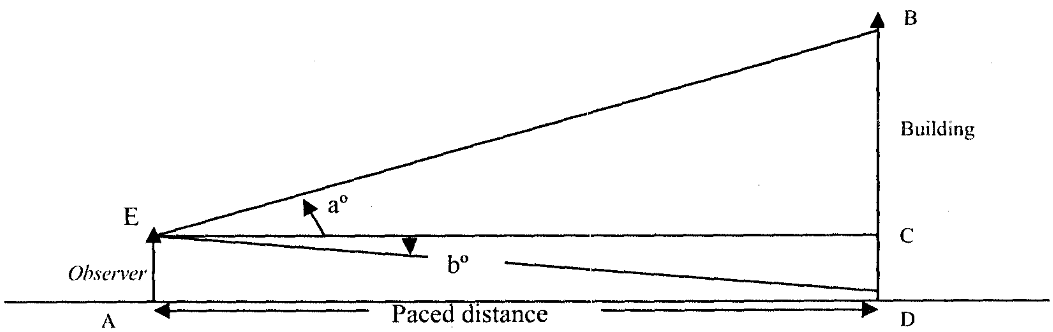

Fig. 1: Height computation using the Suunto Altimeter PM-5

The formula for calculating the height of building using the Suunto Altimeter PM-5 is derived as follows (Figure 1):

Height of Building = BD = BC + CD.................................. (1)

Paced Distance = Base length = AD = EC.......................... (2)

Using basic trigonometry:

$\tan a^o = BC/EC$, implies $BC = EC * \tan a^o$............................ (3)

$\tan b^o = CD/EC$, implies $CD = EC * \tan b^o$........................... (4)

where, a^o and b^o are angles of inclination and depression respectively read on the Suunto Altimeter.

Substituting equations (3) and (4) into equation (1),

$BD = BC + CD = EC * \tan a^o + EC * \tan b^o$.................. (5)

Substituting equation (2) into equation (5),

$BD = AD * (\tan a^o + \tan b^o)$

Therefore,

The height of building = $AD * (\tan a^o + \tan b^o)$

The extruding of the 2D cadastral map was done in ArcGIS 8.2 software. A 2D cadastral map, which has poly-line features, was first converted to polygon features (consisting of buildings and landuse areas) by on-screen digitizing. These polygons were then used to generate the buildings in the ArcScene software. The ArcScene software has the capability of extruding the 2D polygon features of the boundaries of the buildings into 2½D model, using *'extrusions'* in the *'layer properties function'*. Views in 2½D are like bird's eye view, where the user looks down on the model as if it is a three-dimensional view but the user is not immersed within the model.

The ArcScene software has also the capability of converting the 2½D model to 3D model (a 'wrl' format), using the *'export scene function'*. The heights of buildings which were obtained in the field using the Suunto Altimeter PM-5 were used in extruding the 2D polygon features in ArcScene.

Exporting the extruded 2½D boundaries into VRML for development of the 3D virtual environment and texturing of images was done using the Internet Space Builder (ISB) software. With the 'wrl' format, the 3D model can then be used in the ISB software. Within, the ISB software, all the images ('jpg' files) were loaded into its photo gallery. These images were then used for the photo texturing. Well-labelled (or reference) images are required for proper identification of the images. After the photo texturing was done and the application ready, the file containing the application was published, using *'publish function'* in the ISB software. This is very important, as it enables the application to be viewed in any browser. The ISB software provides a VRML platform for the virtual reality. That is, the main platform for this work in developing the virtual model is the ISB software. The final environment for visualizing the application was the Cortona plug-in (Figure 2) for web browser or Internet Explorer.

The 'think aloud' method was used in testing the developed virtual environment. It is a simple technique intended to capture what the test participants (users) are thinking whilst working

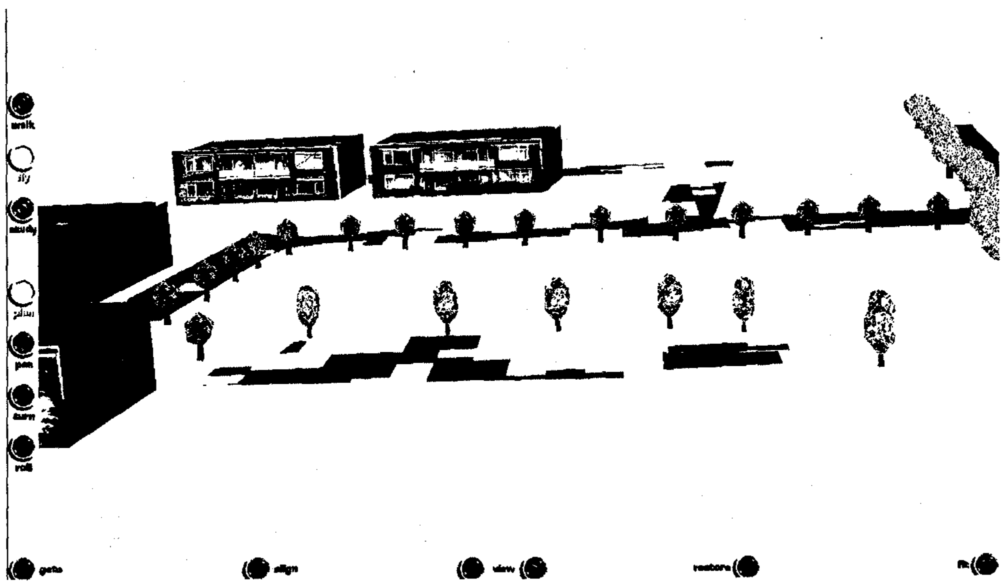

Fig. 2: The developed 3D virtual environment

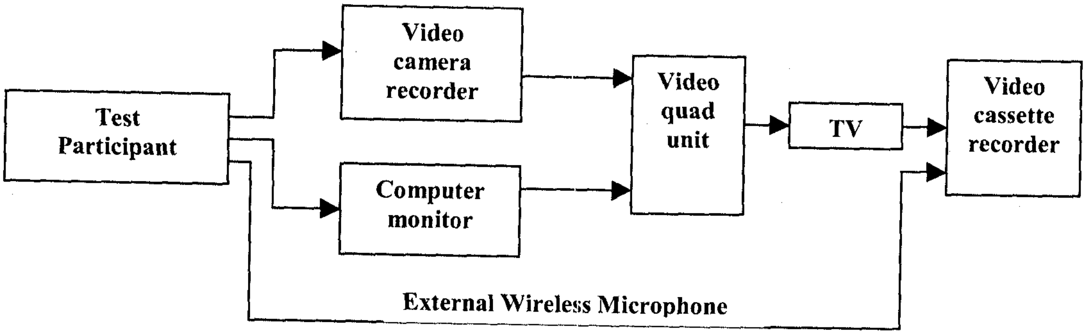

Fig. 3: Mechanism of acquiring user feedback using the 'think aloud' method (Adapted from: Redido-Cusi, 2002).

with the virtual reality application. The method was implemented such that test participant provide a running commentary of their thought process by thinking aloud while performing navigational tasks in the virtual environment. The mechanism of acquiring user feedback using the 'think aloud' method is presented below (Figure 3).

RESULTS AND DISCUSSION

In the survey interview performed, real estate agents used photos to show properties with the aim of presenting pictures of the building. They always wanted to go to the field to show the properties they have for sale. The 3D representations of buildings are not true pictures of the existing buildings but rather artificial images as seen on most web sites. They would prefer a true picture of the buildings rather than artificial ones. Real estate agents claim they will prefer a system that is cheap and affordable.

Real estate agents agreed that potential clients wanted to first see images of properties at their offices before they visit the property. This mechanism according to real estate agents is an effective way of offering property for sale to their clients. According to real estate agents, a 2D image of property does not convey enough information about the property's site and surroundings although it is their normal procedure of presenting property information to their clients. As a result, some real estate agents use video coverage shown on video cassette recorder (VCR) at their offices as an additional tool for presenting property.

Use of a softcopy picture on the computer screen to visualize properties is not part of their normal duties. The scanned images or downloaded images from digital cameras were put into the computer for other purposes, not for their clients. However, a form of image enhancement was applied to images for re-sizing and also correction of image sharpness.

Although real estate agents were content with their system of using pictures, they wished they could link images of properties to cadastral or real world location as well as images of the property to represent the geometry of the property site and its surroundings. They also wished to present properties in three-dimension although they have little idea about visualization. In addition, real estate agents who had little idea about virtual reality think an interactive 3D visualization of property would be an ideal and interesting way for presenting their properties for sale.

The integration and geo-referencing resulted in the 3D realistic view of building (Figure 2). It was discovered, however, that there were small gaps between the textured photo and the geometric model in the ISB software during the process of photo texturing*. The cause could be attributed to the capabilities of the software. A solution could be the use of 'gif' image file formats instead of 'jpg' file format (that is, by loading 'gif' images into the ISB texture gallery instead of the ISB photo gallery). There is a trade off to this solution, as the problem with the gaps will be solved but the image quality will be distorted in the photo texturing. Another solution will be the application of different software, which may need to be investigated.

The conversion from 2D map (model) to 3D model shifted from 2D (plan view) to 2½D (model view) to 3D (model view). That is, moving from to 2D to 3D requires an intermediary 2½D model. Heights of building were measured using the Suunto Altimeter because. The aim of the work was not to obtain very precise measurements of the height of buildings. Other alternatives such as Theodolite and Total Stations could be used if more precise measurement is required.

Although a method was found for the 3D virtual environment, this work did not attempt to compare with other methods for obtaining the best available method for 3D virtual environment. The concept of level of detail makes highly complex scenes feasible to be displayed but this was not introduced in this work since a small working area was considered in developing the prototype.

The final step of this work was to obtain feedback on the efficiency, effectiveness and satisfaction of the designed prototype from test participants who participated in the usability testing. Ten tests participants conducted the testing of the prototype using the 'think aloud' method. These test participants comprising real estate agents were assumed to be buyers of properties. This was done because getting real buyers was a difficult task and also it was not within the scope of this work. From the protocols of the 'think aloud' method, it was discovered that the real estate agents have vague idea about virtual navigation and visualization. A suggestion was that the prototype would be best used for visualizing commercial (bigger) properties rather than domestic properties. This shows that, user (client of real estate agents) demands in visualizing property is not considered much by real estate agents but rather the 'feelings' of the clients. Results drawn from the usability testing for the prototype indicates that the application is satisfactory in terms of use, realistic representation of the environment as well as informing one about a property offered for sale. The application is efficient in terms of the time required to identify property and its surroundings. The application is effective for test participants who are conversant with virtual interface.

**Texturing is the technique of wrapping a photo (or an image) onto a geometrical figure.*

CONCLUSION

In light of the above, it can be seen that there is the need for virtual environment with which stakeholders such as the real estate agent could interact. A 3D visualization is an important tool in visualizing properties. In this respect the real estate agent can use the virtual map as an index to present all the properties of apartments and offices required for sale and maintenance.

The developed product can support three-dimensional (3D) visualization of varied datasets which can be useful to regional planners, environmentalist, geographic information scientist, military, archaeologist, ecologist and the educationist. The output of this work is technically promising idea in the ongoing research into 3D Cadastres being carried out in various countries.

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